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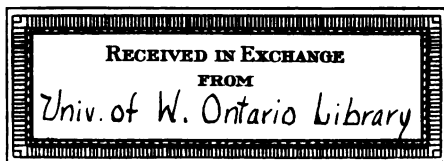
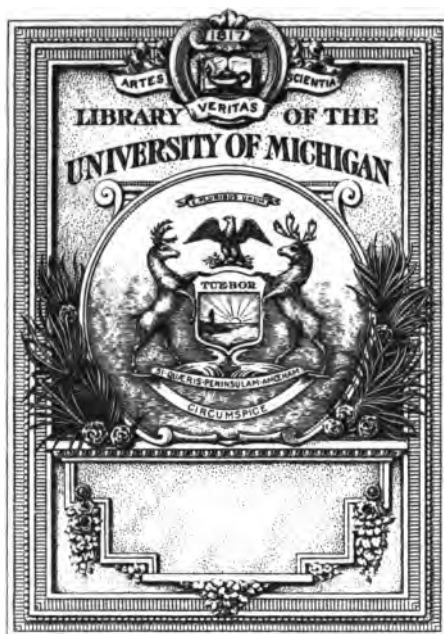
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FOURTH ANNUAL REPORT
OF THE
METROPOLITAN SEWERAGE
COMMISSION

1893



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FOURTH ANNUAL REPORT

OF THE

BOARD

Massachusetts. OF

METROPOLITAN SEWERAGE

COMMISSIONERS.

JANUARY, 1893.

BOSTON:

WRIGHT & POTTER PRINTING CO., STATE PRINTERS,

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1893.



Exch.
N. J. W. On 4. 1892.
P. 27-31

Commonwealth of Massachusetts.

To the Honorable the Senate and the House of Representatives.

The Board of Metropolitan Sewerage Commissioners,
created by chapter 439, Acts of 1889, presents its

FOURTH ANNUAL REPORT.

Progress upon the work intrusted to this Board has continued steadily during the past year. The Charles River valley system has been completed and in use since early in April, the towns and cities embraced within its limits having all availed themselves of the means thus afforded to dispose of sewage. Contracts have been made for nine new sections upon the North Metropolitan system, while eight of those under construction when our last report was made have been completed. On this line the sewer is completed from the southerly end of Deer Island to Belle Isle Inlet, excepting Shirley Gut; also from Belle Isle Inlet to Chelsea Creek, and at various places in Everett, Charlestown and Medford. Work is progressing at the Inlet, on the siphon under Chelsea Creek, and at other points on the line of the main sewer in Chelsea, Everett and Medford. The branch extending into Malden and Melrose is under contract, and should be completed during the coming year. On the Cambridge branch work is progressing at various points in Everett, Somerville and Cambridge; all of this branch between the main line in Everett and the Mystic River, and from the river to the junction of Portland and Bristol streets in Cambridge, is under contract at this date (Oct. 1, 1892).

In the report of our chief engineer, which is submitted herewith, and the tables that follow, these matters are treated more in detail, and your attention is respectfully invited to them in connection with this report.

CHARLES RIVER VALLEY SYSTEM.

The completion of this system leads us to reverse the usual order of our report, and, before speaking in detail of progress upon the North Metropolitan system, your attention is called to some facts connected with the inception and construction of this system. The following quotations from previous reports of this Board present these facts briefly. In its second annual report (House Document, No. 8, 1891) the Board says : —

The Charles River valley, or "southern system," as it is sometimes called (the shorter and smaller of the two, its cost being estimated to be about one-fifth that of the other), has as its object the relief of part of Boston (Brighton), with Brookline, Newton, Watertown and Waltham, by building an intercepting sewer to connect with the present main drainage works of Boston, discharging at Moon Island.

By chapter 63 of the Resolves of 1888, the State Board of Health, in conjunction with its report upon the North Metropolitan district, was "requested to designate some method for the disposal of the sewage" of these cities and towns, and by the same resolve so much of the report of the Massachusetts Drainage Commission (1886) as related thereto was referred to said Board for its further consideration. In its report (Senate Document, No. 2, 1889) the Board of Health, in speaking of this system, says: "Its line is substantially the same as that designated by the Massachusetts Drainage Commission. Its grades have been somewhat lowered near the upper end, to receive sewage from lower and more distant points in Watertown, and the size is somewhat reduced."

The execution of this plan being part of the work intrusted to this Board, an engineering party started in January of the present year (1890), and work was sufficiently advanced by the last of April to enable us to advertise for bids upon two sections (A and B), and contracts were duly made for their construction. (To avoid confusion, the sections upon this system were designated by letter, following the alphabet in regular order, those of the North Metropolitan system having been numbered.) Since then, bids have been received and contracts made upon two other sections (C and D), so that to-day work is progressing upon four sections (A, B, C and D), extending over the line of the sewer from its point of entrance into the main sewer at the junction of Hunting-

ton Avenue and Parker Street, Boston, to the junction of Western Avenue and Waverly Street, Brighton, a distance of 17,900 feet (about 3.4 miles). Surveys have also been made and plans and specifications are in progress upon the remaining sections of this system, which the Board expects to advertise and let during the coming winter.

The third annual report (Public Document, No. 45, 1892) says:—

The construction upon this system has progressed steadily during the past year, and the four sections that were under contract when our former report was presented have either been completed or are sufficiently near that stage to insure completion before winter; while three other sections on which contracts were made early in the present year are so well advanced that their completion may be looked for at no distant day. Their completion means the completion of this system, and, as a natural sequence, its opening in the near future to receive sewage from the towns and cities for whose relief it was designed. Negotiations are now pending with the city of Boston for discharging the sewage from this system through the sewers of that city having outlet at Moon Island.

The contractors upon the three sections here mentioned (sections E, F and G) requested the Board to relieve them from so much of their work as lay between Station 28 on Section G (a point on California Street, Newton, about two hundred feet east of Bridge Street) and the end of the line in Waltham, and the Metropolitan Construction Company of Boston offered to take this portion of the work upon the terms and the prices of the petitioners; so, on Oct. 3, 1892, a contract was made with the latter company for the construction of this portion of the line, covering a distance of about forty-five hundred feet, and said portion was designated and has since been known as Section H. This has been the only contract made for construction on this system during the year.

The sewer in that portion of Huntington Avenue, Boston, lying between Parker and Gainsborough streets, which was built by said city, was, by vote of this Board, passed Sept. 10, 1892, taken as a part of this system (Suffolk Registry, libro 2082, page 325).

On Sept. 16, 1892, the city of Boston, by its engineer with the approval of the mayor, conveyed to the Commonwealth, for the consideration of fifty-nine thousand and seventy-six dollars (\$59,076), "the portion of the improved sewerage system in Huntington Avenue, in said Boston, extending south-westerly from Gainsborough Street to a point south-west of Parker Street, to which point the sewer constructed by the Metropolitan Sewerage Commissioners extends." (Suffolk Registry, libro 2084, page 223.) The following orders, passed by the city council of Boston, authorized such conveyance:—

CITY OF BOSTON.

IN BOARD OF ALDERMEN, Oct. 19, 1891.

Ordered, That the city engineer, with the approval of his honor the mayor, be and hereby is authorized to convey to the Metropolitan Sewerage Commissioners the portion of the improved sewerage system recently constructed in Huntington Avenue, extending south from Gainsborough Street, on such terms as said engineer, with the approval of the mayor, may deem just and equitable. And the amount which shall be received from said commissioners for said sewer is hereby appropriated for the engineering department, to be used in the extension and construction of the improved sewerage system of the city.

Passed. Yeas, 11; nays, none. Sent down for concurrence.

October 22, came up concurred. Yeas, 59; nays, none.

Approved by the mayor Oct. 24, 1891.

A true copy. Attest:

(Signed) JOHN T. PRIEST, *Assistant City Clerk*.

CITY OF BOSTON.

IN BOARD OF ALDERMEN, Sept. 7, 1892.

Ordered, That the city engineer be and hereby is authorized to convey to the Commonwealth of Massachusetts the portion of the improved sewerage system recently constructed in Huntington Avenue, extending south from Gainsborough Street, and to release all claims for damages by the taking of said portion of said system by the Metropolitan Sewerage Commissioners for the sum of fifty-nine thousand and seventy-six dollars (\$59,076), to be paid by said Commonwealth, and the said sum to be credited to the

appropriation for the improved sewerage system, and to be expended by the city engineer in the extension and construction of said system.

Passed. Sent down for concurrence.

September 15, came up concurred.

Approved by the acting mayor Sept. 17, 1892.

A true copy. Attest:

(Signed)

J. M. GALVIN, *City Clerk*.

Table C of the Appendix contains a summary of the various sections upon this line, giving location, length, names of builders and other data of interest connected with the work. The entire route of the sewer on this system has been fully described in our previous reports, and may be traced on the map accompanying the report of our engineer presented herewith.

When our last report was made, negotiations with the city of Boston for receiving sewage from this system into the sewers of Boston, for discharge at Moon Island, had just commenced. The following vote, passed by the city council of Boston, designated the persons to act for said city:—

CITY OF BOSTON.

IN BOARD OF ALDERMEN, Oct. 19, 1891.

Ordered, That the superintendent of streets, under the direction of his honor the mayor, be and hereby is authorized, in behalf of the city, to contract with the Metropolitan Sewerage Commissioners for receiving the sewage of the South Metropolitan Sewerage System into the sewers of the city of Boston, and discharging said sewage at Moon Island, on such terms as said superintendent, with the approval of the mayor, shall deem just and equitable.

Passed. Sent down for concurrence.

November 19, came up concurred.

Approved by the mayor Nov. 21, 1891.

A true copy. Attest:

(Signed)

JOHN T. PRIEST, *Assistant City Clerk*.

In accordance with this vote, Mr. H. H. Carter, the superintendent of streets of Boston, met this Board on Dec. 12, 1891, and agreed, subject to the approval of the mayor of

said city, to the amount that should be paid each year, for four successive years, to said city by the Commonwealth, for receiving and disposing of sewage from this system. The amounts thus agreed upon were as follows: for the years 1892, 1893, 1894, twenty-three thousand dollars (\$23,000) each year; 1895, twenty-four thousand dollars (\$24,000). These amounts receiving the approval of the mayor, an agreement was presented to this Board, and by them accepted and executed in triplicate, of which the following is a copy:—

The COMMONWEALTH OF MASSACHUSETTS, acting by Hosea Kingman, Tilly Haynes and Harvey N. Collison, constituting the Board of Metropolitan Sewerage Commissioners, all duly appointed and acting under the authority of chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine, and the CITY OF BOSTON, acting by Henry H. Carter, its superintendent of streets, hereto duly authorized, on this sixteenth day of April in the year eighteen hundred and ninety-two, agree:—

1. Said city shall take into its sewers, at the corner of Huntington Avenue and Gainsborough Street in said city, all the sewage caused by said commissioners to be discharged at that point from the system of sewers constructed by them under the authority of said act, and shall convey said sewage through its system of sewers and discharge the same at the outlet thereof at Moon Island, for the term of four years from the first day of January, eighteen hundred and ninety-two.

2. Said Commonwealth shall reimburse said city for any and all damages, costs and expenses which said city may be required to pay to others from injuries resulting from the discharge of said sewage into its said sewers, or from conveying the said sewage through its own sewers, or from the discharge of said sewage into the waters of Boston harbor, and will hold the city harmless on account thereof, and shall assume the defence of all actions which may be brought against said city for any of said matters, and shall pay any judgments which may be obtained in said suits against said city.

3. Said Commonwealth shall pay to said city, in each of the years eighteen hundred and ninety-two, eighteen hundred and ninety-three and eighteen hundred and ninety-four, the sum of twenty-three thousand dollars, and in the year eighteen hundred and ninety-five, the sum of twenty-four thousand dollars, the first payment to be made on the first day of July next in the sum of

eleven thousand five hundred dollars, and thereafter on the first days of October, January, April and July, in each of said years, in proportional parts of said yearly payments.

COMMONWEALTH OF MASSACHUSETTS,

(Signed) By HOSEA KINGMAN,
(Signed) TILLY HAYNES,
(Signed) HARVEY N. COLLISON,
Metropolitan Sewerage Commissioners.

CITY OF BOSTON,

(Signed) By H. H. CARTER,
Superintendent of Streets.

In the last annual report of this Board the attention of the Legislature was called to the fact of an early completion of this system, and of the need of providing funds necessary for operating the same. On Sept. 27, 1890, this Board had, in conjunction with its petition to the supreme judicial court, made in pursuance of the provisions of section 13, chapter 439, Acts of 1889, certified to the treasurer of the Commonwealth its estimate of the cost of maintaining and operating this system, as follows : —

To the Treasurer of the Commonwealth of Massachusetts.

The Board of Metropolitan Sewerage Commissioners, in pursuance of the requirements of section 13 of chapter 439, do hereby certify that they estimate the cost of the maintenance and operation of the system of sewage disposal for the cities of Boston, Waltham and Newton, and the towns of Watertown and Brookline (called by us the Charles River Valley System), as follows : —

<i>Item 1.</i>	For the years 1890 and 1891, nothing.	
<i>Item 2.</i>	For the year 1892, taking sewage from all the cities and towns included in said system, . . .	\$26,500 00
<i>Item 3.</i>	For the year 1893, taking sewage from same cities and towns, . . .	26,500 00
<i>Item 4.</i>	For the year 1894, taking sewage from same cities and towns, . . .	27,000 00
<i>Item 5.</i>	For the year 1895, taking sewage from same cities and towns, . . .	28,000 00

In making this estimate, we assume that we shall meet with no more serious obstacles in construction than the work thus far accomplished has developed.

HOSEA KINGMAN,

TILLY HAYNES,

R. T. DAVIS,

Metropolitan Sewerage Commissioners.

By EDWARD P. FISK, *Clerk.*

Boston, Sept. 27, 1890.

These figures were taken as a basis, and an act passed (chapter 281, Acts of 1892) for operating the Charles River valley system of sewerage, the amounts appropriated for the several years being the same as the estimate here given. Table D of the Appendix contains a statement of operating expenses, and shows a balance of \$8,750.40 of the appropriation for 1892 remaining unexpended at this date (Oct. 1, 1892). This amount seems to be sufficient to meet the expenses of operation for the balance of the current year, and, unless something should happen which cannot now be foreseen, will do so.

The towns and cities embraced within this system have, as already stated, connected their local sewers with the Metropolitan sewer, such connections having been made in accordance with plans approved by this Board. The number and location of these connections, with the date each was made, are shown in the following table:—

DATE.	CITY OR TOWN.	LOCATION OF CONNECTION.	REMARKS.
1892.			
April 28, .	Brookline, . . .	Commonwealth Avenue, corner St. Mary Street,	Twenty-four-inch brick sewer, formerly emptied into Charles River.
May 3, .	Boston (Brighton), .	Cambridge Street, corner Seattle Street, . . .	Fifteen-inch branch sewer.
May 3, .	Newton, . . .	At Lemon or Hyde Brook, . . .	Twenty-four-inch branch sewer.
May 4, .	Newton, . . .	California Street, corner Crescent Street, . . .	Twenty-four-inch branch sewer.
May 6, .	Boston (Brighton), .	Rena Street, . . .	Twelve-inch branch sewer.
May 24, .	Boston, . . .	Brookline Avenue, corner Bellevue Street, . . .	Twelve-inch pipe sewer.
May 28, .	Newton, . . .	Nonantum Street, . . .	Ten-inch branch sewer.
May 30, .	Boston, . . .	One hundred and thirty-three feet north of Brookline Avenue, Back Bay Fens, .	- -
June 9, .	Watertown, . . .	California Street, corner Galen Street, . . .	Twenty-four-inch branch sewer.
June 24, .	Waltham, . . .	North Street, corner Calvary Street, . . .	Connected with the end of Metropolitan sewer.
July 9, .	Watertown, . . .	California Street, corner Watertown Street, . . .	Ten-inch branch sewer.
July 9, .	Watertown, . . .	Two places, Water Street, . . .	Two eight-inch pipe sewers.
Sept. 27, .	Boston (Brighton), .	Western Avenue, foot of Market Street, . . .	Eighteen-inch pipe sewer, formerly emptied into Charles River.

The connection on the Back Bay Fens, north of Brookline Avenue, was made at the request of the Park Commissioners of the city of Boston, contained in the following communication : —

BOARD OF COMMISSIONERS, EXCHANGE BUILDING,
BOSTON, April 15, 1892.

To the Metropolitan Sewerage Commissioners.

The Park Commissioners respectfully request that they may be permitted to enter a drain from the proposed administration building on Muddy River near Audubon Road into the main sewer where it crosses lands of this department, the details to be as may be arranged between your engineer and the city engineer.

Respectfully,

(Signed) T. L. LIVERMORE, *Chairman.*

The following letters, received from the local boards of health of Newton and Watertown, were referred to the chief engineer of this Board, and answered by him, for the Board, as here reported : —

OFFICE OF CLERK BOARD OF HEALTH,
WEST NEWTON, MASS., Aug. 6, 1892.

To the Metropolitan Sewerage Commissioners.

GENTLEMEN :— The Board of Health of this city have great trouble in disposing of the contents of the cesspools which are in use. Many of these are now being abandoned. We desire, in order to have no further trouble, to empty the barrel wagons into the sewers at convenient points. Some have thought that you would object, and deny our right so to do. As all this material is pumped through a four-inch hose, and is practically liquid, this Board cannot see any objections to so doing, especially if a proper flushing of water is used afterward. This question of disposal is a vital one with us, and is seriously affecting the health of our citizens from the present manner of disposing of it. An early answer is therefore desired to our request to use our sewers as indicated.

Respectfully,

(Signed) W. S. FRENCH, *Clerk.*

[ENGINEER'S REPLY.]

COMMONWEALTH OF MASSACHUSETTS.

CHIEF ENGINEER'S OFFICE, METROPOLITAN SEWERAGE COMMISSION,
ROOM 5, 93 LINCOLN STREET, BOSTON, Aug. 31, 1892.

To the Board of Health, City Hall, West Newton, Mass.

GENTLEMEN:—The letter of your clerk, in reference to the disposal of cesspool contents, was duly received, and a reply has been delayed until your letter could be seen by all members of our Board. The Board understand you to ask to discharge into your local sewer, and not directly into the Metropolitan sewer. The Sewerage Commissioners feel that they have no authority to allow, and have no authority to forbid, what you request. If anything of an injurious character should reach our sewer through any of your connections with it, it would then be their duty to interfere.

Yours respectfully,

(Signed) H. A. CARSON, *Chief Engineer.*

OFFICE OF BOARD OF HEALTH,
WATERTOWN, MASS., Aug. 23, 1892.

Metropolitan Sewerage Commissioners.

GENTLEMEN:—As chairman of the Board of Health of Watertown, I am seeking to relieve the town of the great nuisance caused by the sewage of the mills in Watertown, Waltham, Newton and the towns above being emptied into the Charles River. I therefore wish to inquire if your commission intend to permit any portion, and if so what, of the sewage from these mills to be emptied into the new Metropolitan sewer. Any information upon the subject would very greatly oblige.

Yours respectfully,

(Signed) BENNETT F. DAVENPORT.

Office address, 161 Tremont St., Boston.

[ENGINEER'S REPLY.]

COMMONWEALTH OF MASSACHUSETTS.

CHIEF ENGINEER'S OFFICE, METROPOLITAN SEWERAGE COMMISSION,
ROOM 5, 93 LINCOLN STREET, BOSTON, Aug. 31, 1892.

DR. BENNETT F. DAVENPORT, *Chairman of Board of Health of Watertown, 161 Tremont St., Boston, Mass.*

DEAR SIR:—The Sewerage Commissioners direct me to say that it is desirable that all sewage should enter the Metropolitan sewer by way of the local sewers. If there are cases where it is

impossible for the sewage of particular establishments to enter the Metropolitan sewer in the way mentioned, the commissioners will consider the question of admitting such sewage directly. It is possible that there are some waste products, not properly called sewage, from the mills, which could not be admitted on account of the injury to the sewer and its operations which might ensue. Hair, tan-bark, sand, gravel and other substances occasionally get into sewers and clog them at various points and interfere with the flow of sewage proper. The commissioners would object to anything entering the Metropolitan sewer which would interfere with its performing its proper functions.

Yours respectfully,

(Signed) H. A. CARSON, *Chief Engineer.*

There have been no settlements effected for land damages on this system during the past year, this Board having been unable to reach any agreement with land owners. Negotiations are pending in some instances, while in others relief has been sought through the courts of the Commonwealth. The only taking of land during the year was made Nov. 4, 1891, in accordance with a plan marked "Commonwealth of Massachusetts. Plan of Land in Brighton, Boston. Additional Lines of Taking. Section E," drawn by Howard A. Carson, chief engineer, dated Nov. 4, 1891. This was done to include within taking lines parts of the sewer in the Abattoir grounds that had lapped outside the former taking, in changing the sewer line during construction, at the request of the owners of the property.

Expenditures upon this system, including all payments on account of contracts, during the twelve months ending this date, amount to \$280,308.29. This, with the amount previously reported, \$389,478.74, makes the total expenditures to date \$679,787.03.

Your attention is called to the tables submitted herewith for matters of detail.

NORTH METROPOLITAN SYSTEM.

This Board, in its last annual report (Public Document, No. 45, 1892), said, of the work upon this system :—

When that report (Second Annual Report, House Document, No. 8, 1891) was submitted, work was in progress upon six sections of this system, covering the line of the main sewer from the site of the proposed pumping station on Deer Island to Chelsea Creek, excluding Shirley Gut and Belle Isle Inlet, tidal waters that this line crosses. Three of these sections are now complete (one of them on Deer Island and two in Winthrop) ; one (Section 5, Winthrop) will be completed before winter, and the two remaining (Sections 8 and 9, East Boston) either in the winter or early spring. Another section on Deer Island (Section 2) was let last June, and work on it has been pushed so vigorously that its completion can be expected before winter.

The sewer upon these sections is all nine feet in diameter, and the entire length of that size, which is the largest upon the system, is included therein.

At the present time the condition of the work upon this system can be readily seen by the following tables, the first showing the sections completed, with the date of completion of each ; the second showing those under construction, the approximate length of each, the number of feet constructed and remaining to be constructed.

North Metropolitan System (Completed Sections).

Section.	Location.	Length of Sections.	Completed.
		Feet.	
Wharf, .	Deer Island, ...	400	Feb. 3, 1891.
2, . . .	Deer Island, ...	2,146	Dec. 19, 1891.
3, . . .	Deer Island, ...	2,641	Aug. 8, 1891.
4, . . .	Winthrop, ...	5,710	June 27, 1891.
5, . . .	Winthrop, ...	4,600	Dec. 2, 1891.
6, . . .	Winthrop, ...	4,113.4	Sept. 30, 1891.
8, . . .	East Boston, ...	4,127.5	June 23, 1892.
9, . . .	East Boston, ...	3,389	June 24, 1892.
15, . . .	Chelsea, ...	1,760	July 20, 1892.
17½, . .	Everett, ...	1,625	Aug. 10, 1892.
21, . . .	Medford, ...	8,035	Sept. 10, 1892.
24, . . .	Everett and Charlestown, .	2,332	June 2, 1892.

North Metropolitan System (Uncompleted Sections).

Section.	Location.	Approximate Length of Sections.	Completed to Sept. 30, 1892.	To be Con- structed.
		Feet.	Feet.	Feet.
7,	Winthrop and East Boston, .	820	468	352
12,	Chelsea, ...	3,050	2,491	559
14,	Chelsea, ...	3,440	2,156	1,284
16,	Everett, ...	4,430	3,196	1,234
17,	Everett, ...	3,550	3,098	452
20,	Medford, ...	9,130	6,227	2,903
22,	Medford, ...	6,080	2,165	3,915
23,	Everett, ...	2,300	1,860	440
26,	Charlestown and Somerville,	4,250	1,375	2,375
27,	Somerville and Cambridge,	4,750	1,363	3,387
40,	Everett and Malden, . .	6,250	4,443	1,807
41,	Malden and Melrose, . .	9,780	2,222	7,558
42,	Melrose and Stoneham, .	3,050	912	2,138

The total length of these sections (101,358.9 feet) equals 19.19 miles, the completed portion (72,954 feet) amounts to 13.81 miles, and there remain to be constructed 5.38 miles (28,404 feet), for which contracts have been made. The map accompanying our engineer's report shows these sections, with their location, and is self-explanatory.

In addition to those previously reported, the following settlements for land takings upon this line have been made.

By deed dated Oct. 26, 1891, recorded in Suffolk Registry (libro 2027, page 269), John S. and Martha P. Ballou grant the right of way through their land in Winthrop. This is accompanied by a quit-claim deed to the Commonwealth from John P. Hazlett, the mortgagee, bearing even date and recorded in Suffolk Registry (libro 2027, page 271), of all his right, title and interest to the land included within the taking.

By deed dated Dec. 14, 1891, recorded in Suffolk Registry (libro 2035, page 306), Frank M. Wells grants to the Commonwealth the right of way across the marsh land in Winthrop, extending from the terminus of a private way called "New Main Street" to land of the Boston, Revere Beach & Lynn Railroad, in the neighborhood of Shirley Station. This deed is accompanied by a bond for five hundred dollars

from said Wells, with two sureties, agreeing "to indemnify the said Commonwealth against all lawful claims for damages . . . arising from any ownership or interest of any person" in the land so conveyed; also by an assignment to said Wells, recorded in Suffolk Registry (libro 2035, page 305), by William B. Rice and Selwyn Z. Bowman, trustees of the Winthrop Shore Land Company, of "all and whatever sum or sums of money now due and coming due to us as trustees aforesaid from the Commonwealth of Massachusetts as damages resulting from the construction and maintenance of the Metropolitan sewer, so called, across the land." The land in question on the date of taking (May 7, 1890) belonged to the land company, and no settlement had been made. With these deeds were two others: one recorded in Suffolk Registry (libro 2035, page 307), from the aforesaid Rice and Bowman, trustees, mortgagees releasing to said Wells the rights taken by the Commonwealth in the land conveyed; the other from Arthur D. McClellan, mortgagee, recorded in Suffolk Registry (libro 2035, page 308), releasing directly to the Commonwealth similar rights in said land.

On May 9, 1892, John W. Belcher, by deed recorded in Suffolk Registry (libro 2060, page 195), and Frederick W. Belcher, by deed recorded in said registry (libro 2060, page 196), conveyed to the Commonwealth the right of way through their respective lands in Winthrop. The amount (\$175) paid said Belchers is covered by the bond given the Commonwealth by Wells, as the land in question was held in bond by him at the time his conveyance was made, and was included in said conveyance.

James and John D. Henderson of Everett, on May 3, 1892, by deed recorded in Middlesex South District Registry (libro 2117, page 2), conveyed to the Commonwealth "the right to carry and conduct under Cross Street and Fleet Street in said Everett and the private way in continuation of said Fleet Street to land now or late of L. P. True, and therein to construct, operate and forever maintain an underground main sewer and connecting sewers, drains, manholes and underground appurtenances, and to repair and renew the same."

One other settlement has been made during the past year.

An estate on Pearl Street, Chelsea, which was included in the taking of this Board made April 9, 1892 (Section 14, Chelsea), was purchased outright for the purpose of construction on that section, which was to be built by tunnelling. This estate was conveyed to the Commonwealth by warranty deed from Fred and Josephine C. Haslam, dated April 28, 1892, Suffolk Registry (libro 2057, page 243).

LAND TAKINGS AND PURCHASES.

When the last report of this Board was made, contracts had just been executed for the construction of sections 20, 23 and 40, in Medford, Everett and Malden. On Oct. 3, 1891, a deed was executed, taking in behalf of the Commonwealth "the right to carry and conduct under . . . and therein to construct, to operate and forever to maintain an underground main sewer and connecting sewers, drains, manholes and underground appurtenances, and to repair and renew the same" in the lands upon these sections. (Middlesex South District Registry, libro 2071, page 162.) On Oct. 28, 1891, similar rights were taken in Everett (Middlesex South District Registry, libro 2076, page 262), covering that portion of Section 17 between Tileston Street and the Malden River which had been purposely omitted from the taking made upon this section in August that year (1891). This taking was modified by another, made April 23, 1892 (Middlesex South District Registry, libro 2111, page 203), by which the line from Tileston Street, opposite Cross Street (Everett), was changed so as to reach Williams Street nearly opposite Norman, by a reversed curve. We omit for the present a statement of the route of the sewer in these and the various other takings made during the past year, intending to speak of it in detail later.

The next takings were made Nov. 25, 1891. One of them (Suffolk Registry, libro 2030, page 547) included Alford Street, Charlestown, from the dividing line between Everett and Boston (Charlestown) to the neighborhood of the Mystic River; the other (Middlesex South District Registry, libro 2083, page 368) comprised Section 21 (Medford), lying between Park and Canal streets in that town. The taking on Section 22 (Medford) was made in

two parts: the first, executed Dec. 23, 1891 (Middlesex South District Registry, libro 2089, page 361), included that portion of the section lying between Prescott Street in that town and land of the Boston & Maine Railroad, lying between the West Medford station and Grove Street on the southern division of that line; the other, executed Jan. 2, 1892 (Middlesex South District Registry, libro 2090, page 291), included that portion of this section extending from the point last mentioned to the junction of this section with the Mystic valley sewer. March 19, 1892, a deed (Middlesex South District Registry, libro 2102, page 560) was signed, taking a right of way in land in Somerville extending from the junction of Poplar and Joy streets across the location of the Boston & Lowell Railroad and through grounds of the McLean Asylum to Asylum Avenue. This was a part of Section 27, and the remainder of the section, extending from the corner of Poplar and Joy streets to the junction of Portland and Bristol streets in Cambridge, was taken by deed dated June 11, 1892. (Middlesex South District Registry, libro 2124, page 126.) Section 26, extending from the neighborhood of Mystic River to Asylum Avenue in the McLean Asylum grounds, lying in both Suffolk and Middlesex counties, was taken May 14, 1892, in two parts. The portion in Suffolk County (Suffolk Registry, libro 2060, page 189) extended from Tuft's Mill Pond to the division line between Boston (Charlestown) and Somerville, on Roland Street. The remainder (Middlesex South District Registry, libro 2117, page 3) included the portion in Somerville between the boundary line and Asylum Avenue. A deed, executed April 9, 1892 (Suffolk Registry, libro 2052, page 196), taking the right of way on Section 14 (Chelsea) extending from the neighborhood of Marginal and Shawmut streets to the corner of Second and Spruce streets, covered the section which is being constructed partly by tunnelling.

Takings have been made during the year on the branch extending into Malden and Melrose. Two of these, the first dated June 11, 1892 (Middlesex South District Registry, libro 2124, page 123), and the second July 23, 1892 (Middlesex South District Registry, libro 2133, page 550), cover

the line of Section 41 from the end of Section 40 at the junction of Charles and Middlesex streets in Malden to the intersection of Pleasant Street and Wyoming Avenue in Melrose. The third taking, dated Aug. 20, 1892 (Middlesex South District Registry, libro 2139, page 329), includes Wyoming Avenue in the towns of Melrose and Stoneham, extending from the easterly line of Pleasant Street (Melrose) to and across Spot Pond Brook in Stoneham.

LOCATION OF SEWER LINE.

Starting on the line of the main sewer in Chelsea on Marginal Street near Shawmut, where the taking (Section 12) made by this Board, Aug. 1, 1891, terminated, the line passes through Marginal Street to its junction with Hawthorn, and continues through private estates from this point to Chelsea Square, excepting where public streets are crossed. Crossing the square and Broadway, the line follows Second Street to its junction with Spruce, the terminus of Section 15, which was taken Aug. 17, 1891. The length of this line is 3,350 feet, of which 2,740 feet lie in public highways and 610 feet in private land. Continuing from this point along the trunk line of the sewer in Everett to Tileston Street, opposite Cross, where the former taking on Section 17 terminated, the line from this point to the Malden River passes through 3,360 feet of private estates and 130 feet of streets. After crossing Malden River the line enters Medford, which is crossed by three sections extending from the river to Mystic Lake. From the river to the tracks of the Boston & Maine Railroad (western division) near Wellington station, the sewer crosses salt marsh, and after passing these tracks the main line follows Third Street to a point in the neighborhood of Winthrop Avenue, where it crosses private land to Ship Street. This street it follows to Riverside Avenue, and then continues in this avenue to Central Square (Medford). A branch for the relief of Edgeworth joins the main sewer in Craddock Avenue near the Wellington station. From Central Square (Medford) High Street is followed for about a thousand feet. The line then deflects towards the river, passes through private estates to the corner of Prescott and Mystic streets, continues through Prescott, Canal and Warren

streets to the neighborhood of Irving Street, where it enters private land, and so continues to the Mystic valley sewer near Mystic Lake. These sections measure 13,510 feet in public highways and 10,530 feet in private lands.

The Malden and Melrose branch, starting from the trunk sewer near the West Everett station on the Saugus branch of the Boston & Maine Railroad, follows the line of the said road to near the Bell Rock station (Malden), thence partly in Canal Street and private lands along said railroad to Middlesex Street, thence through Middlesex Street, Dartmouth Street and private land to Mountain Avenue, thence along Spot Pond Brook through private estates, across Ripley Street and the brook, and thence deflecting westerly towards the Boston & Maine Railroad (western division) follows said railroad to the neighborhood of the Fells station, near which it crosses said road and continues through private land to Pleasant Street, which it follows to Wyoming Avenue and continues in that avenue until Spot Pond Brook in Stoneham is crossed and there terminates. Thirteen thousand and sixty-four feet (13,064) of the line on these three sections are in private land, and sixty-nine hundred and seventy feet (6,970) in public highways.

The branch coming south for the relief of Cambridge, Somerville and Charlestown starts from the main sewer in Everett, near a branch of Island End River, about one thousand feet southerly from the Everett station on the eastern division of the Boston & Maine Railroad. From this point the line passes through private land and a private way called Ashland Street to Beacham Street, and continues through Beacham, Bow and Alford streets to the Mystic River. Crossing the river, it passes through Tuft's Mill Pond property, recently purchased by the city of Boston for park purposes, continues through Sullivan Square and Cambridge Street to the tracks of the Boston & Maine Railroad at East Somerville, under which it passes by tunnel to Roland Street, thence through this street to the McLean Asylum grounds, under the Boston & Lowell Railroad, through Poplar Street to Somerville Avenue, crosses said avenue and private land to Medford Street, and continues through Medford, Warren and Portland streets to the

junction of the latter street with Bristol Street in Cambridgeport. Thirty-nine hundred and eighty feet (3,980) of the sewer on this line lie in private land, and eighty-five hundred and seventy feet (8,570) in public ways.

The Board of Harbor and Land Commissioners were asked during the year to assent to plans for construction of work in contact with tide-water. They have assented to plans for "the construction of a main sewer in and over the tide-waters of creeks and ditches flowing into Mystic River, between High Street and Winthrop Street in the town of Medford," and new plans for a sewer, siphon, pumping station and wharf at Chelsea Creek. The following correspondence passed between this Board and the War Department at Washington, D. C., in relation to the latter: —

BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS,
93 LINCOLN ST., BOSTON, Aug. 20, 1892.

To the Hon. STEPHEN B. ELKINS, Secretary of War of the United States of America.

Respectfully represents the Board of Metropolitan Sewerage Commissioners of Massachusetts, created under and in pursuance of an act of the General Court of said Commonwealth entitled "An Act to provide for the building, maintenance and operation of a system of sewage disposal for the Mystic and Charles River valleys," approved June 7, A.D. 1889, and being chapter 439 of the Acts of said year, a copy of which, together with other documents, was submitted to your honorable predecessor in office with the petition of this Board, bearing date of March 21, 1892, that your department approved, April 9, 1891, various constructions pertaining to the Metropolitan sewerage system, and, among others, a siphon under Chelsea Creek, between East Boston and Chelsea, the location of which siphon was shown on tracing No. 832 (submitted on the same date as the petition above mentioned) as below Chelsea Bridge. This Board now desires to change the location of the pumping station, and have the siphon built above Chelsea Bridge, as shown in detail by the tracing No. 1325, submitted herewith. Mr. Howard A. Carson, our chief engineer, is at your service to furnish any further information you may desire.

Wherefore this Board respectfully requests that the said work, as last above described, may be authorized, approved and permitted.

(Signed) HOSEA KINGMAN,
Chairman Metropolitan Sewerage Commissioners.

OFFICE OF THE CHIEF OF ENGINEERS UNITED STATES ARMY,
WASHINGTON, D. C., Sept. 6, 1892.

MR. HOSEA KINGMAN, *Chairman Metropolitan Sewerage Commissioners,*
Boston, Massachusetts.

SIR: — I have to acknowledge the receipt, by reference, of your letter of the 20th ultimo to the Secretary of War, in which you refer to certain plans for a siphon under Chelsea Creek, Boston harbor, approved by the War Department April 9, 1891, and make application on behalf of the Board of Metropolitan Sewerage Commissioners of Massachusetts for permission to change the approved plans so as to have the siphon built above the Chelsea drawbridge, as shown on a drawing submitted.

In answer thereto, I have to advise you that under date of the 5th instant the Secretary of War approved the changes proposed by the commissioners; and a blue-print copy of the drawing showing the same is sent you herewith.

Very respectfully, your obedient servant,

(Signed)

H. M. ADAMS,

Major Corps of Engineers, in charge.

CONTRACTS.

Contracts have been made for the construction of nine sections on this line during the past year. The methods of advertising, receiving bids and awarding contracts were the same as mentioned in our previous reports, and are there explained fully. The first bids of the year were received Nov. 4, 1891, for the construction of three sections, the number on each section being as follows: —

Section 21 (Medford), eight. Section 22 (Medford), four. Section 24 (Everett and Charlestown), five.

The National Construction Company, the lowest bidder upon Section 21 (Medford), received that contract, while subsequently the Board by its vote rejected all bids upon Section 22 (Medford), and awarded Section 24 (Everett and Charlestown) to the Metropolitan Construction Company.

Your attention is called to tables A and B in the Appendix, which give details of bids received upon these and other sections during the year.

Upon Dec. 9, 1891, a petition was presented by Christy McBride, contractor upon Section 17 (Everett), asking "that he be relieved from the obligation of building and complet-

ing that part of Section Seventeen (17) of the Metropolitan sewerage system which extends from a point fifty feet westerly of station thirty-five in Everett to the westerly end of said section near the Malden River."

The Metropolitan Construction Company of Boston offered to take this portion of the work upon the contract terms and prices of the petitioner. The prayer of said petitioner was granted on Dec. 23, 1891, and a contract was executed with said Construction Company for the construction thereof, and that part of said section has since then been designated as Section 17½.

On Jan. 30, 1892, bids were again received for the construction of Section 22 (Medford). The number of bids was four, and the contract was awarded to Andrew W. Bryne, the lowest bidder, who executed the same.

Bids were opened Feb. 27, 1892, for construction of two sections in Chelsea. These sections provided for alternate routes in the same locality, one by tunnelling, the other by open cut, and were solicited to determine the comparative expense by each method; notice being given, in the advertisement soliciting bids, of the rejection of one upon the adoption of the other. Section 13 was by open cut; Section 14, by tunnelling. The number of bids received was as follows:—

Section 13 (Chelsea), five. Section 14 (Chelsea), seven.

All bids for Section 13 were rejected, and the Board awarded the contract for Section 14 to the Metropolitan Construction Company of Boston, the lowest bidder, who furnished bonds and executed the contracts. Your attention is called in this connection to tables A and B, already referred to.

Bids were next received on April 2, 1892, for the construction of Section 26 (Charlestown and Somerville). The number of bids was seven. This contract was awarded to the lowest bidder, Harry P. Nawn, who in due time furnished bonds and executed the contracts.

On May 7, 1892, eleven bids were deposited for the construction of Section 27 (Cambridge and Somerville), and the contract was awarded to the lowest bidders, McGovern & Kitch of Lancaster, Pa., they furnishing bonds and signing contracts in due season.

The Board on June 4, 1892, received bids for construction of Section 41 (Malden and Melrose), eight bids being deposited. Moulton & O'Mahoney, the lowest bidders, received the award and duly executed the contracts.

The next contract made embraced the works and siphon at Belle Isle Inlet, between East Boston and Winthrop. Proposals were received for the construction of this section (Section 7) June 25, 1892, when five bids were made, and later the contract was awarded to Charles A. Trumbull and Wm. H. Ryan, the lowest bidders, who furnished bonds and executed contracts.

On July 16, 1892, bids were received for the construction of Section 42 (Melrose and Stoneham). Seven proposals were submitted, and David S. Clements, the lowest bidder, received the award and furnished sureties with his contract.

About two months later (Sept. 10, 1892) five bids were received for the construction of a siphon across Shirley Gut (Section 3½). These proposals were, after due deliberation, all rejected by vote of the Board, for good and sufficient reasons.

The contract price for these sections amounts to \$563,217.-70. Add to this the amount previously contracted for and reported in our last report, \$1,205,372.65, and a total of \$1,768,590.35 is the amount of the contracts upon the North Metropolitan system to date.

EXPENDITURES.

The expenditures upon this system, including all payments on account of contracts, during the twelve months ending this date, amount to \$962,798.49. This, with the amount previously reported, \$699,458.61, makes the total expenditures to date \$1,662,257.10.

Your attention is called to the tables submitted herewith for matters of detail.

During the year \$7,703.15 have been expended that is chargeable to both systems in general, which amount, added to that formerly reported, \$8,294.06, makes \$15,997.21 so spent to this date. The expenditures of this Board to date may be stated concisely thus:—

North Metropolitan system, ...	\$1,662,257 10
Charles River valley system, ...	679,787 03
Both systems, ...	15,997 21
	\$2,358,041 34
Engineering, administrative and contingent expenses, ...	91,612 19
Total expenditures to date, ...	\$2,449,653 53

GENERAL—BOTH SYSTEMS.

The following communication reached this Board Sept. 30, 1891, and was only alluded to in our former report : —

To the Honorable Board of Metropolitan Sewerage Commissioners of Massachusetts, 93 Lincoln Street, Boston, Mass.

GENTLEMEN:—At a meeting, held last evening, of the joint committee on sewerage, appointed by the citizens of Revere, Mass., in public meetings assembled, the chairman was instructed to communicate with your honorable Board, asking for information on the following points, to wit : —

1. What facilities can be provided by your commission for the town of Revere to discharge its sewage into the North Metropolitan sewer, now being constructed by your Board?
2. What will be the approximate cost to the town of Revere for constructing the section of sewer necessary to connect a system of sewerage for Revere with the North Metropolitan system?
3. Will it be necessary to pump — within the town of Revere — the sewage of the town, in order to discharge the same by gravity into the North Metropolitan sewer?
4. What will be the approximate annual expense to the town of Revere for the maintenance of the North Metropolitan system of sewers?

This information is sought in anticipation of a special town meeting soon to be held for the purpose of considering sewerage and sewage disposal for the town of Revere, and is of the utmost importance to our people in their endeavors to learn the most feasible mode of disposing of the sewage of the town.

Be pleased to make answer to us at the earliest practicable date, and greatly oblige
Yours very truly,

(Signed)

WILLIAM H. COLCORD,

Chairman Citizens' Joint Committee on Sewerage of Revere.

REVERE, MASS., Sept. 25, 1891.

Reply was sent as follows : —

BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS,
93 LINCOLN ST., BOSTON, Oct. 3, 1891.

MR. WILLIAM H. COLCORD, *Chairman Citizens' Committee on Sewerage of Revere, Revere, Mass.*

DEAR SIR : — In partial reply to the first and second questions in your communication of Sept. 25, 1891, we refer you to page 58 in the report on the sewerage of the North Metropolitan system, a marked copy of which has been forwarded to you. We are not at present possessed of any information by which we can review or modify the estimate and statement there given.

We have not the necessary topographical data to answer with certainty your third inquiry, but will state that the branch of the Metropolitan sewer at the vicinity of Mill Creek and the Eastern Railroad would probably have its bottom about three feet below mean low water. It seems probable that some pumping would be required.

In reply to the fourth question, we would say that the proportion of annual expense to the different towns in the system has not been left for this Board to decide. Please see section 13, chapter 489 of the Acts of 1889, given on page 7 of the pamphlet mailed you.

The foregoing is the best information that we can give you as promptly as you require. If your town decides to take further action in the matter, we should be glad to have a conference with any committee which it may select.

Yours respectfully,
(Signed) HOSEA KINGMAN, *Chairman.*

Later in the year another committee of citizens of Revere, Michael Sullivan, chairman, Arthur B. Curtis, secretary, waited upon this Board, asking information, which was furnished as follows : —

BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS,
93 LINCOLN STREET, BOSTON, Dec. 9, 1891.

Messrs. MICHAEL SULLIVAN, *Chairman*, ARTHUR B. CURTIS, *Secretary*,
Special Committee on Sewerage, Revere, Mass.

GENTLEMEN : — This Board does not see any reason for changing its estimate of expense to your town for entering the North Metropolitan System, given in its letter of Oct. 3, 1891, to William H. Colcord, chairman.

So far as the cost of operation is concerned, we find by the census of 1890 that the towns and cities embraced in the North

Metropolitan district contain a population of 302,032. By the same census Revere has 5,668, or approximately one and seven-eighths per cent. as many as the entire district. The estimated expense of operation when sewage shall be taken from all the cities and towns in the system the entire year is \$89,000. One and seven-eighths per cent. of the amount would be about \$1,675, which might be taken approximately as the annual expense of operation to Revere.

To recapitulate : —

Estimated additional cost of branch to Revere, . . .	\$86,000
Annual operating expense (approximate only), . . .	1,675

For the Board, truly yours,

(Signed) EDWARD P. FISK, *Clerk.*

The town of Wakefield also sent the following to the Board : —

WAKEFIELD, MASS., Dec. 24, 1891.

To the Metropolitan Sewerage Commissioners.

GENTLEMEN : — At a regular meeting of the voters of the town of Wakefield, held in November last, a committee was appointed for the purpose of reporting a plan of sewerage and sewage disposal to the town. This committee is required by the town "to ascertain the expense of connecting Wakefield with the Metropolitan system of sewerage."

In further explanation of this question, and in aid of your reply, I will add that a plan of sewerage was devised for the town in 1889 by Frederick Brooks, C.E., in which the engineer makes the following statement : —

"A line of levels has been run down to the point in Melrose Highlands at which it has been proposed to start a sewer forming part of the Mystic valley system reported upon to the Legislature, Feb. 4, 1887, by the State Board of Health ; to reach that point, a depth of about twenty feet for a distance of about half a mile would be required."

Respectfully yours,

(Signed)

SAMUEL W. ABBOTT, *For the committee.*

To this the following reply was sent : —

BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS,
93 LINCOLN STREET, BOSTON, Dec. 30, 1891.

SAMUEL W. ABBOTT, M.D., *Wakefield, Mass.*

DEAR SIR : — Your communication of Dec. 24, 1891, asking "the expense of connecting Wakefield with the Metropolitan system of

sewerage," was duly received and laid before this Board. There seems to be doubt, if, under existing statutes, this Board has any power to take any "land, rights of way or easements" necessary to extend the sewer to your town. Section 3 of the act (chapter 439, Acts of 1889) gives this Board power to contract with cities and towns outside of the Metropolitan district "for the extension thereto of either of said systems of sewage disposal, and for the reception and disposal of sewage therefrom," while the succeeding section gives the right to take lands, etc., by eminent domain, *only* for "carrying out . . . the recommendations and plans of said State Board of Health contained in said report." (Senate Document, No. 2, 1889.) Wakefield, as you are well aware, was not included in the Metropolitan district, and it therefore seems as though this Board were powerless to secure the necessary land for laying the sewer to your town unless additional legislation be obtained.

For the Board,

(Signed)

EDWARD P. FISK, *Clerk*.

APPORTIONMENT OF EXPENSES.

In answer to the petition of this Board made to the supreme judicial court of the Commonwealth, asking for the appointment of commissioners to apportion the cost of construction and maintenance of both systems upon the several cities and towns included in said systems, in accordance with the provisions of section 13 of chapter 439, Acts of 1889, the following decree appointing such commissioners was made:—

SUFFOLK, ss. SUPREME JUDICIAL COURT. IN EQUITY.

HOSEA KINGMAN ET ALS., METROPOLITAN SEWERAGE COMMISSIONERS, PETITIONERS.

And now, upon the above-entitled petition, it is ordered that Ebenezer R. Hoar, of Concord, William C. Endicott, of Salem, and John E. Sanford, of Taunton, be, and they are hereby, appointed commissioners under section 13 of chapter 439 of the acts of the year 1889, to determine the proportions in which the several cities and towns named in said act shall annually pay money into the treasury of the Commonwealth for the term of five years next following the year of the first issue of the scrip or certificates therein named, for the purposes therein set forth, and to perform all other duties and to exercise all powers imposed or

conferred by law upon the three commissioners whose appointment is provided for in and by said section 13 of said act.

By the Court,

JOHN NOBLE, *Clerk*.

MAY 26, 1891.

Their award follows : —

AWARD OF COMMISSIONERS.

The undersigned, Ebenezer R. Hoar, William C. Endicott, and John E. Sanford, appointed by the court upon the above-entitled petition as the commissioners under section 13 of chapter 439 of the acts of the year 1889, to determine the proportion in which the several cities and towns named in said act shall annually pay money into the treasury of the Commonwealth for the term of five years next following the year of the first issue of the scrip or certificates therein named, for the purposes therein set forth, and to perform all other duties and to exercise all powers imposed or conferred by law upon the three commissioners whose appointment is provided for by said section 13 of said act, — as appears by the copy of the order of said court hereto annexed, — have attended to and completed the duty thus assigned to them, and do now report to the court :

That we, the said commissioners, appointed a time and place for hearing all the parties interested in the matters submitted to our determination, and gave due notice thereof to the Attorney-General, who replied that he did not think it necessary for the Commonwealth to appear, and to the treasurer of the Commonwealth, and to the Board of Metropolitan Sewerage Commissioners, and to each of the cities and towns named in the act aforesaid ; and that all of said cities and towns, by their respective officers, solicitors, or counsel, have attended at the time and place appointed for such hearing, or at the adjournments thereof, with such witnesses and evidence as they have seen fit to produce, and have been heard by all of us sitting together as fully as they or any of them have desired. Said public hearings were held, with the assent of all parties, at the State House in the city of Boston, on the twenty-first day of July, the fifteenth, eighteenth, twenty-ninth, and thirtieth days of September, and the sixth and seventh days of October, 1891.

And now, after hearing the parties, their allegations, evidence, and arguments, and after such further investigations as we have found it necessary or desirable to make, and after carefully weighing all the facts and considerations which have been presented or have occurred to us, or which were suggested in

the recent opinion of the full court in this case as elements which ought to be taken into consideration in making a just and equitable apportionment of the moneys to be paid by the several cities and towns as aforesaid, we find, determine, and award as follows:—

Chapter 439 of the acts of 1889 provides for the construction, maintenance, and operation as public works of two systems of trunk and intercepting sewers which are together adapted to receive, convey, and discharge into the sea the entire sewage of a large and populous metropolitan district, embracing the city of Boston and seventeen other cities and towns in the Charles and Mystic river valleys.

The first system, known as the North Metropolitan system, and having its outlet at Deer Island, includes Arlington, Belmont, the East Boston and Charlestown districts of Boston, Cambridge, Chelsea, Everett, Malden, Medford, Melrose, Somerville, Stoneham, Winchester, Winthrop, and Woburn.

The second system, known as the Charles River system, and having its outlet at Moon Island, takes in the rest of Boston, with Brookline, Newton, Waltham, and Watertown.

Both systems are required by the act to “be in substantial accordance with the plans reported and recommended by the State Board of Health in its report to the legislature of 1889.”

The North Metropolitan system is accordingly to be all of new construction, excepting a minor section of trunk sewer extending from the Woburn line down to the lower Mystic lake, which had been built by the city of Boston for the protection of its water supply. This section is to be incorporated into the system by purchase or otherwise, so that the whole of this system will be the property of the Commonwealth and under its immediate control.

Of the Charles River system, on the contrary, by far the larger and more costly part was already built. The city of Boston, at a cost of about \$4,250,000, had constructed for its own use a trunk sewer, with the necessary pumping and other works, from the intersection of Huntington Avenue and Camden (now called Gainsborough) Street down to Moon Island; and had thus provided for the sewage of substantially its whole territory (not tributary to the other system), excepting the Brighton district and an area of some nine hundred acres adjacent to Brookline and the south bank of Charles River. The report of the State Board of Health recommends the extension of this trunk sewer from Camden Street up the Charles River valley to Waltham, and that arrangements be made with Boston to receive and discharge through this

sewer the sewage which should be collected and brought to Camden Street by such extension.

The city sewer from Camden Street down to Moon Island is thus made an essential part of the plan of the Charles River system ; and, in order to insure the working of the system as a whole, in case of failure to make amicable arrangements with the city, the act gives to the Commonwealth the right to purchase or take, or to enter and use by agreement or otherwise, any existing sewer necessary for carrying out the plans and recommendations of the State Board of Health.

Two courses are therefore open under the act ; *first*, the city of Boston may continue to own, maintain, and operate as heretofore the section below Camden Street, receiving and handling at the same time, for a compensation to be fixed by agreement or otherwise, the sewage delivered by the section above Camden Street ; or, *second*, the Commonwealth may purchase or take from the city the section below Camden Street, and so hold, maintain, and operate the entire Charles River system as its own.

In the first case, the cost (estimated at about \$800,000) of the upper section only, and the expense (including the compensation paid the city as above) of maintaining and operating that section only, would require to be provided for and apportioned under the act ; and in that case it is obvious that only that part of Boston which is tributary to the upper section should be made to contribute with the other cities and towns to such cost and expense. In the second case, the cost (probably exceeding \$5,000,000), as well as the very largely increased expense of maintenance and operation of the entire system from Waltham to Moon Island, would require to be provided for and apportioned under the act ; and in this case it is equally clear that all that portion of Boston which is tributary to the entire system should contribute to the cost and expense.

We have found it necessary, therefore, before making the apportionment for this system, to ascertain which of the above courses is likely to be adopted ; and we are satisfied, upon the evidence and the best information at our command, that for the present, and probably during the whole term of five years covered by this award, the section below Camden Street will continue to be owned, maintained, and operated by the city of Boston, but under an arrangement to receive, pump, and discharge at Moon Island, for an agreed compensation, the sewage from the section above Camden Street. We are advised that negotiations to this end, including also the purchase by the Commonwealth of the sewer recently built by the city from Camden up to Parker Street in the line of the upper section, are already well advanced.

We have accordingly made the apportionment for the Charles River system upon the assumption that this will be substantially the course pursued ; and in so doing have included with the other cities and towns in this system only so much of the city of Boston as is tributary to the section above Camden Street. If, however, it should hereafter be found expedient for the Commonwealth to purchase or take from the city the section below Camden Street, and at so early a day as to require a revision of this award before its term expires, it will be possible for the General Court, while making (as it must) provision by an increased loan or otherwise, to meet the large additional cost which such purchase or taking would involve, to provide also, if no other way appear, for such reapportionment for this system as its changed conditions may then require.

The moneys which the several cities and towns are required to pay annually into the treasury of the Commonwealth are for two distinct purposes : first, to meet the interest and sinking fund requirements of the Metropolitan sewerage loan, which the act authorizes to be issued, to the amount of \$5,000,000, for defraying in the first instance the cost of constructing the two systems ; and, second, to meet the annual cost of the maintenance and operation of the systems after they are completed. The amounts of money which may be necessary from year to year for each of these purposes are to be ascertained in the manner prescribed in the act. We have only to determine the proportions in which the respective amounts, when so ascertained, shall be paid in by the several cities and towns.

We have come to the conclusion that there is, upon the whole, no method more just and equitable than to apportion the payments on account of the interest and sinking fund requirements of the loan, which represents the first cost of the systems, with primary reference to the total taxable valuations of the several cities and towns ; and the payments on account of the cost of maintenance and operation, with primary reference to their respective populations ; making, however, in both cases such deductions or allowances in favor of any city or town as upon the facts justice and equity may seem to require. Thus, for example, the valuation and population of areas which are physically so situated that they cannot be drained into these systems, have been excluded in favor of the cities and towns within whose limits such areas lie.

The valuations of May 1, 1890, and the national census of that year, have been used for the purposes aforesaid. To the total values of real and personal estate, as assessed by the local boards, have been added the values, as furnished us by the tax commis-

sioner, of all bank and corporation stocks and ships and vessels, the taxes on which are paid or accrue under state laws to the several cities and towns.

The act provides but one loan for the construction of both systems, and one sinking fund for its redemption at maturity. It is necessary, therefore, to determine in the first place the proportion in which each system as a whole should contribute to the interest and sinking fund requirements of the entire loan. Each system should evidently contribute in the ratio of its cost. This cannot be exactly known until the construction has been completed, but it can be estimated with substantial accuracy. The detailed estimates of the cost of each system contained in the report of the State Board of Health before referred to, have been carefully revised at our request by the Board of Metropolitan Sewerage Commissioners, who have already made considerable progress in the execution of the work. As nearly as can now be ascertained, we find that the cost of constructing the North Metropolitan system will be eighty-five per cent., and that of the Charles River system fifteen per cent., of the whole cost of constructing both systems; and, as between the two systems, we determine these to be the proportions in which they should respectively contribute to the interest and sinking-fund requirements of the whole loan.

We next determine, upon the basis before outlined, the proportion or percentage which each of the cities and towns in the North Metropolitan system should pay of the eighty-five per cent., and each of the cities and towns in the Charles River system of the fifteen per cent., apportioned as above to said systems, respectively; and by combining the two percentages, we obtain the proportions in which the several cities and towns in both systems should contribute to the interest and sinking-fund requirements of the whole loan. The percentages for each system, and the resulting proportions for both systems, are tabulated below.

We determine and award that the several cities and towns named in said act shall annually pay money into the treasury of the Commonwealth, for the term of five years next following the year of the first issue of the scrip or certificates of debt therein named, to meet the interest and sinking-fund requirements for each of said years, as estimated by the treasurer of the Commonwealth, and any deficiency in the amount previously paid in, as found by said treasurer, in the proportions set against the names of said cities and towns, respectively, in the right-hand column of the following table: —

Table showing the Proportions in which the Several Cities and Towns shall pay Money to meet Interest and Sinking Fund Requirements under Chapter 439 of the Acts of 1889.

CITY OR TOWN.	System.	Percentages.	Proportions.
		Each System.	Both Systems.
Arlington, . .	North Metropolitan,	2.45 of 85.00	2.08
Belmont, . .	North Metropolitan,	1.53 of 85.00	1.30
Boston, . .	North Metropolitan,	20.45 of 85.00	} 20.88
Boston, . .	Charles River,	23.02 of 15.00	
Brookline, . .	Charles River,	34.32 of 15.00	5.15
Cambridge, . .	North Metropolitan,	27.87 of 85.00	23.69
Chelsea, . .	North Metropolitan,	8.46 of 85.00	7.19
Everett, . .	North Metropolitan,	3.10 of 85.00	2.64
Malden, . .	North Metropolitan,	7.47 of 85.00	6.35
Medford, . .	North Metropolitan,	4.94 of 85.00	4.20
Melrose, . .	North Metropolitan,	2.65 of 85.00	2.25
Newton, . .	Charles River,	26.82 of 15.00	4.02
Somerville, . .	North Metropolitan,	12.83 of 85.00	10.91
Stoneham, . .	North Metropolitan,	1.33 of 85.00	1.13
Waltham, . .	Charles River,	10.61 of 15.00	1.59
Watertown, . .	Charles River,	5.23 of 15.00	.79
Winchester, . .	North Metropolitan,	1.99 of 85.00	1.69
Winthrop, . .	North Metropolitan,	1.32 of 85.00	1.12
Woburn, . .	North Metropolitan,	3.61 of 85.00	3.07
Total, . .			100.00

The annual cost of the maintenance and operation of each system is required by the act to be estimated by the Board of Metropolitan Sewerage Commissioners and certified to the treasurer of the Commonwealth. This has been done for each of the five years covered by this award, and copies of the estimates are printed in the second annual report of said board, at pages 21 and 22.

It appears by the estimate for the North Metropolitan system that the progress of the work is expected to be such that the seven lower cities and towns in this system can have the use of the sewer twelve months earlier than the seven upper ones. The estimated expense for this period (\$62,400) should evidently be treated as chargeable to the lower seven only, and the balance of the estimated expense for the term (\$126,600) as chargeable to all the cities and towns in the system. The apportionment for this system has been made accordingly.

In other respects, the cost of maintenance and operation for both systems has been apportioned on the basis hereinbefore indicated. The results are tabulated below.

We determine and award that the several cities and towns named in said act, and belonging to each of said systems, shall annually

pay money into the treasury of the Commonwealth for the aforesaid term of five years, to meet the cost of maintenance and operation of said systems, respectively, for each of said years, as estimated by the said board and certified to said treasurer, and any deficiency in the amount previously paid in, as found by said treasurer, in the proportions set against the names of said cities and towns, respectively, in the following table:—

Table showing the Proportions in which the Cities and Towns in Each System shall pay Money to meet Cost of Maintenance and Operation under Chapter 439 of the Acts of 1889.

NORTH METROPOLITAN SYSTEM.		CHARLES RIVER SYSTEM.	
CITY OR TOWN.	Proportions.	CITY OR TOWN.	Proportions.
Arlington, ...	1.25	Boston (Brighton and part of city proper), ...	25.05
Belmont, ...	.46	Brookline, ...	14.16
Boston (East Boston and Charlestown), ...	22.65	Newton, ...	29.35
Cambridge, ...	26.39	Waltham, ...	22.82
Chelsea, ...	10.52	Watertown, ...	8.62
Everett, ...	4.14		
Malden, ...	8.68		
Medford, ...	2.46		
Melrose, ...	1.86		
Somerville, ...	15.14		
Stonham, ...	1.36		
Winchester, ...	1.08		
Winthrop, ...	1.02		
Woburn, ...	2.99		
Total, ...	100.00	Total, ...	100.00

We find as a fact that the first issue of the scrip or certificates of debt authorized by said act was made in April of the year 1890. The understanding of all parties, so far as appears, that the term of five years covered by this award embraces the calendar years 1891 to 1895, both inclusive, seems to us to be correct.

EBENEZER R. HOAR.

WILLIAM C. ENDICOTT.

JOHN E. SANFORD.

Filed Nov. 12, 1891.

The petitioners filed, on Jan. 20, 1892, a motion for the acceptance of the award, which had been objected to in December, 1891, by the town of Brookline, and in January, 1892, by the city of Newton.

The court, on Jan. 26, 1892, entered

FINAL DECREE.

This cause coming on to be heard upon the motion of the petitioners for the acceptance of the award returned into this court on the twelfth day of November, A.D. 1891, by the commissioners appointed by this court under the provisions of chapter 439 of the acts of the year 1889, and the objections of the city of Newton and town of Brookline to the acceptance of the said award having been argued by counsel, and no other party objecting to the acceptance of said award, thereupon, upon consideration thereof, it is ordered, adjudged, and decreed that said award is hereby accepted by this court, and declared to be a final and conclusive adjudication of all matters referred to said commissioners under the provisions of said act, and to be binding on all parties.

By the Court, JOHN NOBLE, *Clerk*.

JAN. 26, 1892.

From this decree said Brookline and Newton appealed to the full bench, where said decree was sustained. The expenses attending these proceedings were \$2,519.35, of which amount \$1,800 was paid to the three commissioners for their services, by order of the court.

The Legislature provided by chapter 68, Acts of 1892, for advances not exceeding ten thousand dollars at any one time to this Board or its clerk, which has greatly facilitated the payment of laborers and other employees, and has enabled us also to meet our bills without unreasonable delay. There has been advanced in this way, since the act went into effect (March 16, 1892), about one hundred thousand dollars (\$100,000), which has been disbursed and properly accounted for to the auditor of the Commonwealth. The salary of the chief engineer was advanced to seventy-five hundred (\$7,500) dollars per annum Nov. 1, 1891, and that of the clerk to twenty-five hundred (\$2,500) Jan. 1, 1892.

The annual meeting of the Board was held, as provided by the act, on the first Monday of February (Feb. 1, 1892); and Hosea Kingman of Bridgewater was chosen chairman, and Edward P. Fisk of Boston clerk, for the year.

On March 9, 1892, Harvey N. Collison of Boston became a member of this Board. He was appointed to succeed Matthew Keany of Boston, who died Feb. 28, 1892, and

who had been appointed and confirmed as successor of Robert T. Davis of Fall River, but had not qualified.

The Appendix contains tables showing in detail the receipts and expenditures for the year ; also the assets and liabilities at date.

HOSEA KINGMAN,
TILLY HAYNES,
HARVEY N. COLLISON,

Metropolitan Sewerage Commissioners.

Boston, Oct. 1, 1892.

REPORT OF THE CHIEF ENGINEER.

REPORT OF THE CHIEF ENGINEER.

Boston, Sept. 30, 1892.

HOSEA KINGMAN, TILLY HAYNES, HARVEY N. COLLISON, *Metropolitan Sewerage Commissioners*:

GENTLEMEN: — It is now two and one-third years since the work of construction began on the Metropolitan sewerage. Measuring the work done by its proportionate value, about 54 per cent. of the whole system has been completed, and about 9 per cent. more is under contract or being done by the day. If we omit from consideration pumping stations and siphons, 64 per cent. of the sewerage system is completed. Work is in progress on two of the siphons, and surveys and studies have been made for the pumping stations and remaining siphons and for a considerable part of the remaining sewers.

The Metropolitan sewer in the Charles River valley, for the towns of Waltham, Watertown, Newton, Brighton, Brookline and part of Boston proper, was completed last winter and was in operation early in the spring. The North Metropolitan sewer is complete (except pumping stations and siphons) from the southerly end of Deer Island, through Deer Island, Winthrop and East Boston, to Chelsea Creek, and considerable portions of the main sewer are done in Chelsea, Everett, Malden, Melrose, Medford, Charlestown, Somerville and Cambridge. The parts completed and the parts under contract can be most readily seen by an examination of the annexed progress map. Construction will have been begun before winter on another contract section in Cambridge and on the Metropolitan sewer for Arlington, Belmont, Somerville and Cambridge, in the Alewife Brook valley. Bids may be opened during the winter for parts of the sewer for Winchester, Woburn, Stoneham and East Boston.

Detailed information concerning the work done during the year ending to-day, on contract sections and on sections done by the day, is given in the following pages. The Charles River valley sections are designated by letters, and

those of the North Metropolitan district by numbers. Mr. William M. Brown, Jr., has had general charge of construction on most of the sewers built this year, except as follows: siphon sections 7 and 10, where Mr. H. H. Marden, Jr., has had general charge of preliminary and construction work, and sections E, F, G and H, where Mr. Sidney Smith has had general charge of construction. Mr. Fred V. Fuller has had general charge of the giving of lines and grades and making estimates and record plans on sections 8, 9, 12, 14, 15, 16, 17, 17½, 23 and 40. Some of the other persons employed on these sections are mentioned in the detailed statements which follow.

Hitherto there has been reported an entire and fortunate freedom from fatal accidents. This year, however, one occurred on Section 16, and is alluded to in the part of this report relating particularly to that section. Other accidents without loss of life, such as are incidental to deep and difficult excavation, have occurred, and some of them will be mentioned in the detailed paragraphs which follow.

SECTION E, BRIGHTON.

Location. — From Waverly Street on Western Avenue, through the avenue to Market Street, thence through the Abattoir road, and beside the Boston & Albany Railroad to a point near the city line of Newton.

Length of section, ... 8,027 feet.

Diameter of sewer, 4 feet 6 inches by 5 feet 1 inch.

Contractors. — Jones & Meehan of Jamaica Plain, Mass.

Contractors' Superintendent. — Michael Tallent.

State Assistants (Year ending Sept. 30, 1892).

Inspectors: Henry M. Woodward, Patrick McCarthy, Warren A. Rogers.

Transitmen: Principals — E. Elbert Young, Fred Brett.

“ Assistants — Harry Cleary, Wm. M. Stodder, Nathan B. Wilber.

Trench.

Length completed, ... 8,027.00 feet.

Average depth of excavation to bottom of underdrain, . 14.70 “

Greatest depth of excavation to bottom of underdrain, . 23.00 “

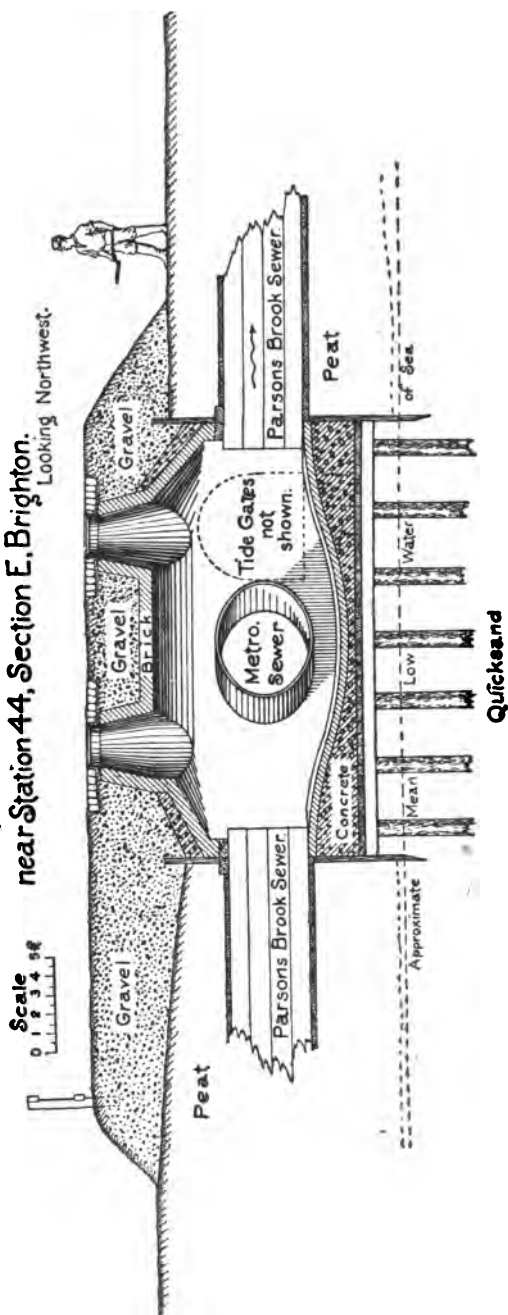
Average width top of trench, ... 9.30 “

Average width bottom of trench, ... 7.30 “

Cubic yards excavation per linear foot, 4.53.

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below grade, etc., \$4.60.

Oblique, Section
On Center Line of Parsons Brook Sewer,
near Station 44, Section E, Brighton.



Character of Earth Excavation.—About equally divided between peat, gravel and clay, with a small proportion of hard-pan.

Masonry.

Contract price:—

Brick-work, American cement mortar, per cubic yard, . . .	\$12 00
Brick-work, Portland cement mortar, per cubic yard, . . .	13 50
Concrete, American cement mortar, per cubic yard, . . .	4 40
Concrete, Portland cement mortar, per cubic yard, . . .	6 00
Approximate cost of masonry per linear foot, including piles, platform and underdrain, ...	8 20
Length completed, ...	8,027 feet.

Work begun, April 2, 1891; finished, March 24, 1892.

Approximate cost of section per linear foot of trench and masonry, including gravel embankment over sewer, labor, material, inspection and miscellaneous items, ... \$14 40

NOTE. — The information regarding Section E following this note relates solely to the year ending Sept. 30, 1892. For a description of the work performed prior to this year, see the third annual report.

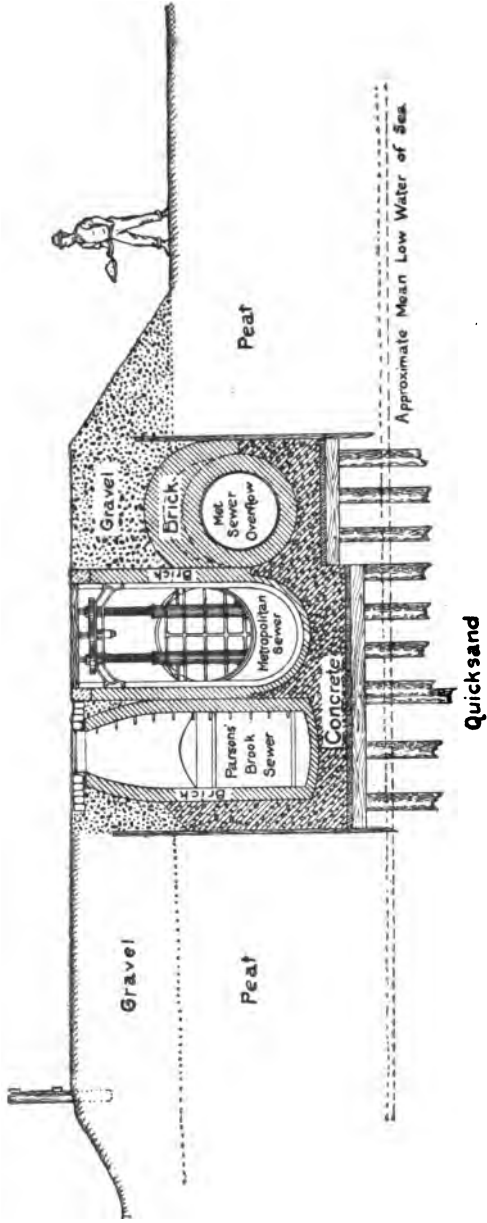
Excavation.—A trench machine was used. Work progressed from the river side of the main Abattoir building to a point near Faneuil station. One six-inch pump, together with six, eight and ten inch underdrain, kept the trench clear of ground water.

Foundation.—The bottom of the trench was excavated to fit the invert of the sewer for a distance of about 100 feet near the Abattoir buildings, and westerly from North Beacon Street for a distance of about 600 feet. Quicksand was encountered at Parson's Brook, and there the sewer was placed on a pile foundation, and in a few places double sheeting was driven. Piles were driven also in the Abattoir road, from the main building to the old ice house. Their average length was 17 feet, and they were driven in bents, with eight by ten-inch caps and three-inch platform.

Difficulties.—Special work was placed at Parson's Brook crossing, where, as noted above, quicksand occurred. The axes of the city sewer and the Metropolitan sewer are here near together. The Metropolitan sewer is at this point a heavy iron pipe, 4 feet 10 inches in diameter, passing through the Parson's Brook sewer by a design satisfactory to the Boston authorities.

Cross-section at Right Angle
Penstock at Parsons' Brook Sewer
Section E, Brighton.
Looking West

Scale
0 1 2 3 4 5 6



Progress. — Two gangs were at work. The ordinary progress of one per week was 114 feet, and of the other 145 feet. Operations were carried on without serious interruption.

Miscellaneous. — To protect the sewer from frost and tide-water, an embankment was built by the State along the base of the slope of the Boston & Albany Railroad. Its top was 4.2 feet above the crown of the arch, or at an elevation of 15.4 feet above mean low water. The surplus earth from the sewer was used for filling in the Abattoir grounds and for the embankment just mentioned.

SECTION F, NEWTON AND WATERTOWN.

Location. — From a point east of the Brighton and Newton town line, north of and near the Boston & Albany Railroad, along the railroad and through private grounds near the Charles River, to and through Water Street in Watertown to Galen Street, through this and California Street to the Newton town line.

Length of section, ... 7,673 feet.

Diameters of sewers, and length of each size:—

4 feet 2 inches by 4 feet 9 inches, ... 5,709 "

3 feet 11 inches by 4 feet 5 inches, ... 1,964 "

Contractors — Jones & Meehan of Jamaica Plain, Mass.

Contractors' Superintendent. — Michael Tallent.

State Assistants (Year ending Sept 30, 1892).

Inspectors: R. H. Sumner, Caleb Kimball, Patrick McCarthy, B. L. Sykes.

Transitmen: Principals — E. Elbert Young, C. Barton Pratt, Fred Brett.

" Assistants — Harry Cleary, Nathan B. Wilber, Wm. M. Stodder.

Trench.

Length completed, ... 7,673.00 feet.

Average depth of excavation to bottom of underdrain, ... 10.40 "

Greatest depth of excavation to bottom of underdrain, ... 17.60 "

Average width top of trench, ... 8.40 "

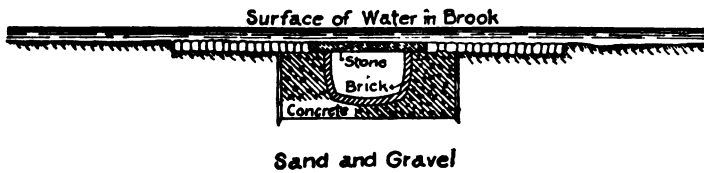
Average width bottom of trench, ... 7.10 "

Cubic yards excavation per linear foot, 3.13.

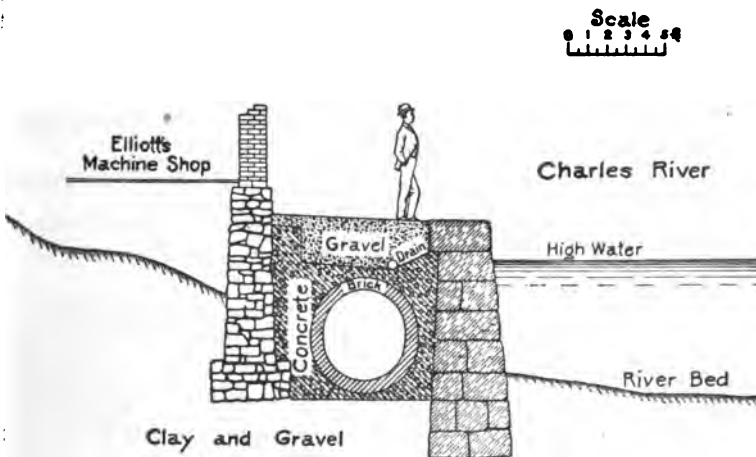
Approximate cost of trench per linear foot, including
sheeting left in, excavation and refilling below grade,
etc., \$3.90.

Character of Earth Excavation. — More than half gravel, larger part of remainder hard-pan, some sand and clay.

Cross-section at Station 58,
Section H,
Crossing Cheesecake Brook.
Newton. Scale. Looking Northwest.



Cross-section near Station 41,
Section F,
Passing Elliott's Machine Shop,
Watertown.
Looking Northwest



Masonry.

Contract price:—

Brick-work, American cement mortar, per cubic yard, . . .	\$13 00
Brick-work, Portland cement mortar, per cubic yard, . . .	14 50
Concrete, American cement mortar, per cubic yard, . . .	4 40
Concrete, Portland cement mortar, per cubic yard, . . .	6 00
Approximate cost of masonry per linear foot, including under- drain, etc., ...	8 70
Length completed, ...	7,673 feet.

Masonry begun, April 3, 1891; finished, Jan. 22, 1892.

Approximate cost of section per linear foot of trench and masonry,
including river wall, slope paving, labor, material, inspection
and miscellaneous items, ... \$16 40

NOTE.—The information regarding Section F following this note relates solely to the year ending Sept. 30, 1892. For a description of the work performed prior to this year, see the third annual report.

Excavation.—The excavated earth was thrown out by hand, and the work progressed from near Elliott's machine shop to a point about 900 feet west of Galen Street. The trench was kept clear of ground-water by using a six-inch pump say one-third of the time, together with six-inch and ten-inch underdrain.

Difficulties.—An earth dam was made by the contractors in the Charles River for several hundred feet in the vicinity of Elliott's machine shop. High tides several times broke through this and flooded the work. At Porter's Raceway, and at a culvert 200 feet west of it, the sewer was widened and the arch depressed. The Metropolitan sewer, where it passed the culvert at Laundry Brook, was built of four-feet iron pipe.

Progress.—Two gangs were employed. The ordinary progress of one gang per week was 86 feet, and of the other 34 feet. The slow progress of this latter occurred while they were constructing the earth dam above alluded to and the river wall. The floodings above mentioned caused shut-downs at various times.

Miscellaneous.—From Lawson's boat house westerly for about 300 feet slope paving was laid to protect the embankment from the river. For the first 1,700 feet of this section, and from Lawson's boat house to Barker's starch works, a distance of about 1,600 feet, the crown of the arch came near



Section F, Watertown. River wall near Barker's Starch Factory.



the original surface. After building the sewer the surplus material was made to form an embankment, its top being at an elevation of 15.4 feet above mean low water, and covering the arch for a depth of 2.5 to 4 feet, thus protecting the sewer from frost and tide-water of the Charles River.

SECTION G, NEWTON.

Location. — Westerly through California Street, from the Watertown line, to near Bridge Street.

Length of section, ... 2,800 feet.

Diameters of sewers and length of each size: —

3 feet 11 inches by 4 feet 5 inches, . . . 1,255 "

3 feet 6 inches by 4 feet, . . . 1,545 "

Contractors. — Jones & Meehan of Jamaica Plain, Mass.

Contractors' Superintendent. — Michael Tallent.

State Assistants (Year ending Sept. 30, 1892).

Inspectors: John D. Collins, B. L. Sykes.

Transitmen: Principals — E. Elbert Young, Fred Brett.

" Assistants — Harry Cleary, Wm. M. Stodder, Nathan B. Wilber.

Trench.

Length completed, ... 2,800.00 feet.

Average depth of excavation to bottom of underdrain, . 19.10 "

Greatest depth of excavation to bottom of underdrain, . 26.70 "

Average width top of trench, ... 10.00 "

Average width bottom of trench, ... 6.00 "

Cubic yards excavation per linear foot, 5.68.

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below grade, etc., \$1.35.

Character of Earth Excavation. — Sand, gravel, bowlders, hard-pan and rock.

Masonry.

Contract price: —

Brick-work, American cement mortar, per cubic yard, . . \$12 00

Brick-work, Portland cement mortar, per cubic yard, . . 13 50

Concrete, American cement mortar, per cubic yard, . . 4 40

Concrete, Portland cement mortar, per cubic yard, . . 6 00

Approximate cost of masonry per linear foot, including underdrain, etc., ... 6 20

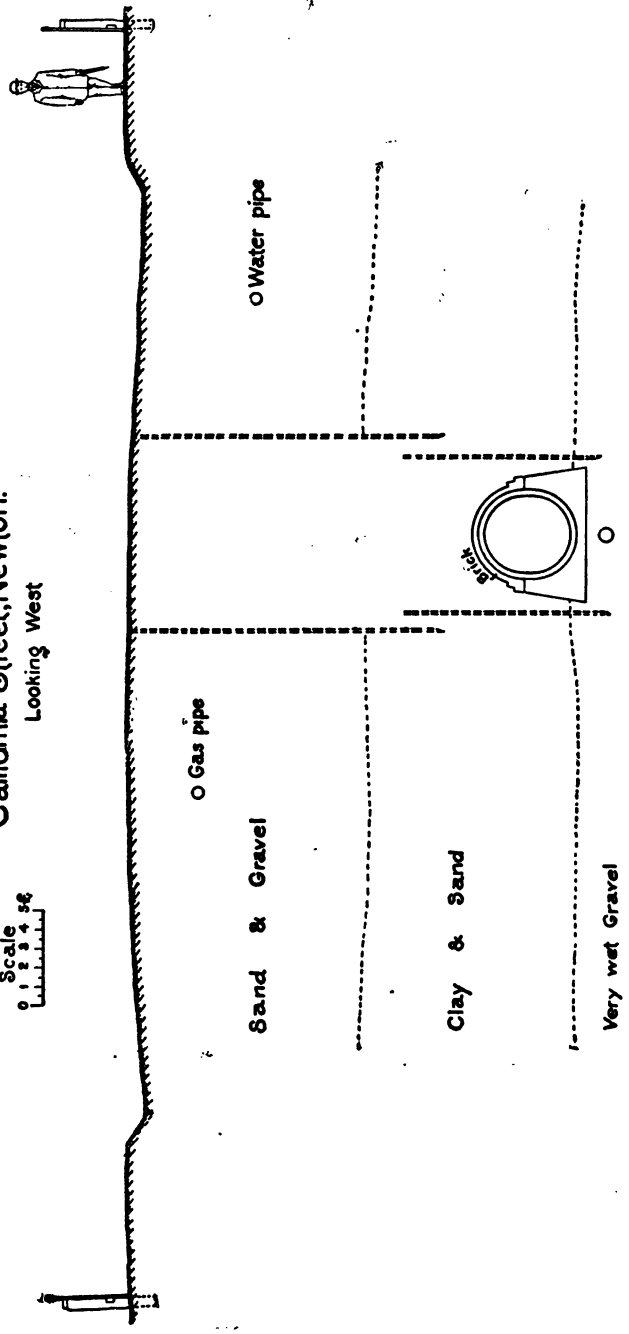
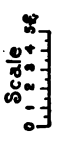
Length completed, ... 2,800 feet.

Masonry begun, June 2, 1891; finished, Nov. 23, 1891.

Approximate cost of section per linear foot of trench and masonry, including labor, material, inspection and miscellaneous items, \$11 50

NOTE. — The information regarding Section G following this note relates solely to the year ending Sept. 30, 1892. For a description of the work performed prior to this year, see the third annual report.

Cross-section near Station 12
Section C
California Street, Newton.
Looking West



Excavation. — A trench machine was used. The work progressed westerly from near Dalby Street to the end of the section, near Bridge Street. A six-inch pump, together with six-inch and eight-inch underdrain, kept the trench clear of ground-water.

Foundation. — For the whole extent of the work done this year the bottom of the trench was excavated to fit the invert of the sewer.

Progress. — One gang was employed. Its ordinary progress per week was 111 feet.

SECTION H, NEWTON.

Location. — From a point 200 feet east of Bridge Street, through private land near the south bank of the Charles River to and through Farwell Street to the junction of North and Calvary streets in Waltham.

Length of section, ... 4,517 feet.

Diameter of sewer, 3 feet 6 inches by 4 feet.

Contractors — Metropolitan Construction Company of Boston, Mass.

Contractors' Superintendent. — George W. Judd.

State Assistants (Year ending Sept. 30, 1892).

Inspectors: B. L. Sykes, John D. Collins.

Transitmen: Principals — C. Barton Pratt, Fred Brett, E. Elbert Young.

“ Assistants — Harry Cleary, Wm. M. Stodder, Nathan B. Wilber.

Trench.

Length completed, ... 4,517.00 feet.

Average depth of excavation to bottom of underdrain, . . . 13.70 “

Greatest depth of excavation to bottom of underdrain, . . . 25.50 “

Average width top of trench, ... 7.60 “

Average width bottom of trench, ... 5.20 “

Cubic yards excavation per linear foot, 3.31.

Contract price of rock excavation per cubic yard, \$4.50.

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below grade, etc., \$5.00.

Character of Excavation — About 900 feet of rock, 1,000 feet of clay and 2,600 feet of sand and gravel.

Masonry.

Contract price: —

Brick-work, American cement mortar, per cubic yard, . . . \$12 00

Brick-work, Portland cement mortar, per cubic yard, . . . 13 50

Concrete, American cement mortar, per cubic yard, . . . 4 40

Concrete, Portland cement mortar, per cubic yard, . . . 6 00

Approximate cost of masonry per linear foot, including underdrain, ...	\$5 15
Length completed, ...	4,500 feet

Masonry begun, Sept. 12, 1891; finished, April 13, 1892.

Approximate cost of section per linear foot of trench and masonry, including labor, material, inspection and miscellaneous items, ...	\$11 80
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NOTE. — The information regarding Section H following this note relates solely to the year ending Sept. 30, 1892. For a description of the work performed prior to this year, see the third annual report.

Excavation. — A trench machine and derricks were used. A length of 230 feet, situated about in the middle of this section, had been done previous to the present year, and the work this year covered the remainder. A six-inch pump, together with four-inch, six-inch and eight-inch underdrain, kept the trench clear of ground-water.

Foundation. — From the westerly end of the section to Cheesecake Brook the bottom of the trench was excavated to fit the invert of the sewer; also for about 30 feet on the easterly side of the Cheesecake Brook. At this point for a distance of about 40 feet quicksand was found, and the invert was reinforced with concrete. Thence easterly for about 400 feet the trench was excavated to fit the invert of the sewer; for about 200 feet a section of concrete was used in the invert; for about 900 feet the trench was excavated to fit the invert of the sewer. At this point the trench was excavated below sewer grade for 6 inches and refilled with gravel. In other portions of the trench on Section H concrete was used in the invert.

Difficulties. — While the sewer operations were in progress at Cheesecake Brook that stream was diverted. The regular sewer cross-section at that point was modified by depressing and widening.

Progress. — Three gangs were employed. The ordinary progress per week was 80 feet in rock and side-hill work. On other work, including that at Cheesecake Brook, the progress was 165 feet per week.

Miscellaneous. — The surplus earth from the sewer was placed by the contractors as filling on the low lands adjoining the Charles River.



Section 2, Deer Island, near new wharf. November 3, 1891.

HELIOTYPE PRINTING CO., BOSTON.

SECTION 2, DEER ISLAND.

Location. — From the southerly end of Deer Island, northerly near the westerly shore of the island to the old hospital building, (a gap of about 310 feet being left here for a pumping station, etc.), thence along the westerly shore of the island, past the new wharf, to a point about 500 feet south of the receiving house of the institution on Deer Island.

Length of section, ... 2,136 feet.

Diameters of sewers, and length of each size: —

Outfall sewer, 6 feet by 6 feet to 6 feet by 10 feet, 1,615 "

Main sewer, 9 feet 1 inch, ... 505 "

Contractors. — National Construction Company of Boston, Mass. Thomas J. Young was general manager. A. E. Weaving was their general foreman.

State Assistants (Year ending Sept. 30, 1892).

Assistant Engineer and Inspector: Edmund S. Davis.

Transitmen: Principal — Guy C. Emerson.

" Assistant — B. A. Clark.

Trench.

Length completed, outfall sewer, 1,627 feet; main sewer, 509 feet, ... 2,136.00 feet.

Average depth of excavation to bottom of underdrain, outfall sewer, ... 17.00 "

Average depth of excavation to bottom of underdrain, main sewer, ... 28.00 "

Greatest depth of excavation to bottom of underdrain, outfall sewer, ... 20.00 "

Greatest depth of excavation to bottom of underdrain, main sewer, ... 31.00 "

Average width top of trench, outfall sewer, ... 10.00 "

Average width top of trench, main sewer, ... 12.50 "

Average width bottom of trench, outfall sewer, ... 9.50 "

Average width bottom of trench, main sewer, ... 11.00 "

Cubic yards excavation per linear foot, outfall sewer, 6.30.

Cubic yards excavation per linear foot, main sewer, 11.40.

Approximate cost of entire trench per linear foot, including sheeting left in, excavation and refilling below grade, etc., \$11.50.

Character of Earth Excavation. — Sand, gravel and clay in outfall sewer trench, hard blue clay in main sewer trench.

Masonry.

Contract price : —

Brick-work, American cement mortar, per cubic yard, . .	\$12 00
Brick-work, Portland cement mortar, per cubic yard, . .	13 50
Concrete, American cement mortar, per cubic yard, . .	4 95
Concrete, Portland cement mortar, per cubic yard, . .	6 25
Approximate cost of masonry per linear foot, including under- drain, etc., ...	15 70
Length completed, outfall sewer, 1,615 feet; main sewer, 505 feet, ...	2,120 feet.

Masonry begun, July 28, 1891; finished, Nov. 21, 1891.

Approximate cost of section per linear foot of trench and masonry, including labor, material, inspection and miscellaneous items, ...	\$29 15
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NOTE. — The information regarding Section 2 following this note relates solely to the year ending Sept. 30, 1892. For a description of the work performed prior to this year, see the third annual report.

Excavation. — A trench machine was used on the outfall sewer trench, and an “A frame” derrick on the main sewer trench. Where the sewer line was very close to the shore, not far from the old hospital, the sea-water found its way through the coarse sand at the upper stages of the tide faster than the six-inch centrifugal pump was able to take it out. The underdrain used on this section was six, eight and twelve inch. No trouble was experienced from water in the main sewer trench.

Foundation. — The bottom of the outfall sewer trench built this year was excavated to fit the invert of the sewer for 132 feet, and the same was done for the whole length of the main sewer trench.

Difficulties. — The principal obstacles to progress were the considerable depth of trench and the trouble with the tide-water already described. At the latter locality the mortar used for the masonry was made richer, and where the most trouble occurred neat Portland cement was used. The brick invert of this masonry was in one or two instances washed by the water filling the bottom of the trench, but whenever washed out it was torn down and rebuilt before the arch was completed.



Section 4, near Taft's Hotel, Winthrop. Centres and supports in place. August 4, 1890.

Progress. — Three gangs were employed. Under favorable conditions the ordinary progress of each gang per week was about as follows: 120 feet on the outfall sewer, and 16 and 32 feet respectively on the main sewer. The work was carried on without interruption, and was completed about three months in advance of the date named in the contract.

Miscellaneous. — An embankment with its top 7 feet in height above mean high water was built over the outfall sewer for a length of 1,365 feet, from a point about 250 feet from the southerly end of the island to the old hospital; and the last 700 feet of this was protected on the harbor side by riprap. Some of this riprap was injured in the winter and repaired last spring. Additional work will be done in this locality when the pumping station is built. The protection of the shore from the new wharf to the northerly end of the contract section was undertaken by the island authorities.

SECTION 5, WINTHROP.

Location. — From Beacon Street through Shirley Street to Shirley Station, and thence across the marsh to the extension of New Main Street.

Length of section, ... 4,600 feet

Size of sewer, equivalent to circle of 9 feet 1 inch diameter.

Contractors. — Metropolitan Construction Company of Boston, Mass

Contractors' Superintendent. — George W. Judd.

Contractors' Foreman. — James Long.

State Assistants (Year ending Sept. 30, 1892).

Assistant Engineer and Inspector: Willbur F. Goodrich.

Trench.

Length completed, ... 4,600.00 feet.

Average depth of excavation to bottom of underdrain, . 16.00 "

Greatest depth of excavation to bottom of underdrain, . 16.00 "

Average width top of trench, ... 16.00 "

Average width bottom of trench, ... 13.00 "

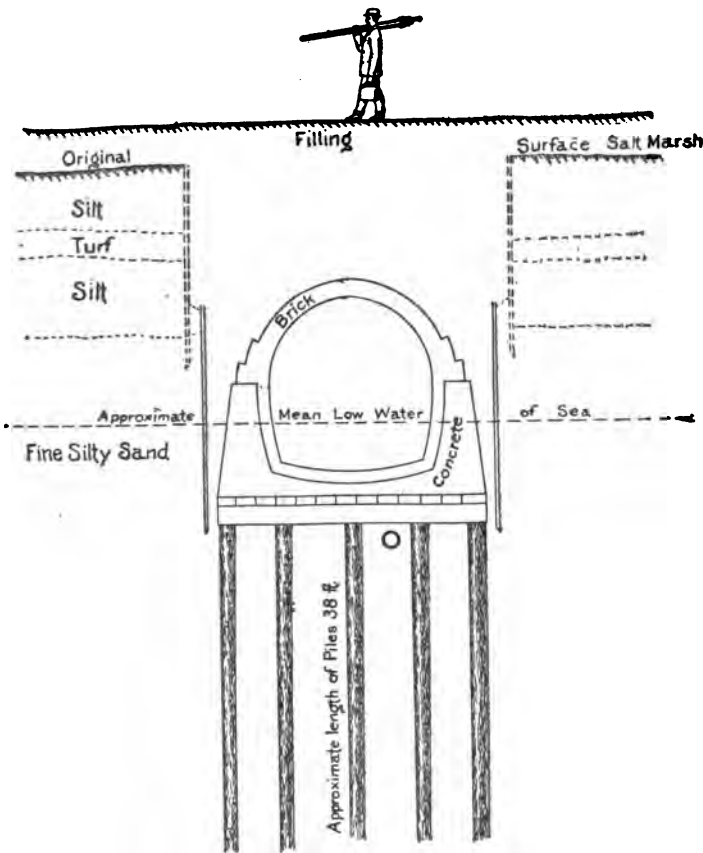
Cubic yards excavation per linear foot, 8.60.

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below grade, etc., \$10.80.

Character of Earth Excavation. — Peat, gravel, silt.

Cross-section near Station 29,
Section 5,
Winthrop.

Scale.
0 1 2 3 4 5 ft.



Masonry.

Contract price: —

Brick-work, American cement mortar, per cubic yard, . . .	\$12 95
Brick-work, Portland cement mortar, per cubic yard, . . .	14 85
Concrete, American cement mortar, per cubic yard, . . .	4 30
Concrete, Portland cement mortar, per cubic yard, . . .	5 94
Approximate cost of masonry per linear foot, including piles, platform and underdrain, ...	21 90
Length completed, ...	4,600 feet.

Masonry begun, June 26, 1890; finished, Nov. 17, 1891.

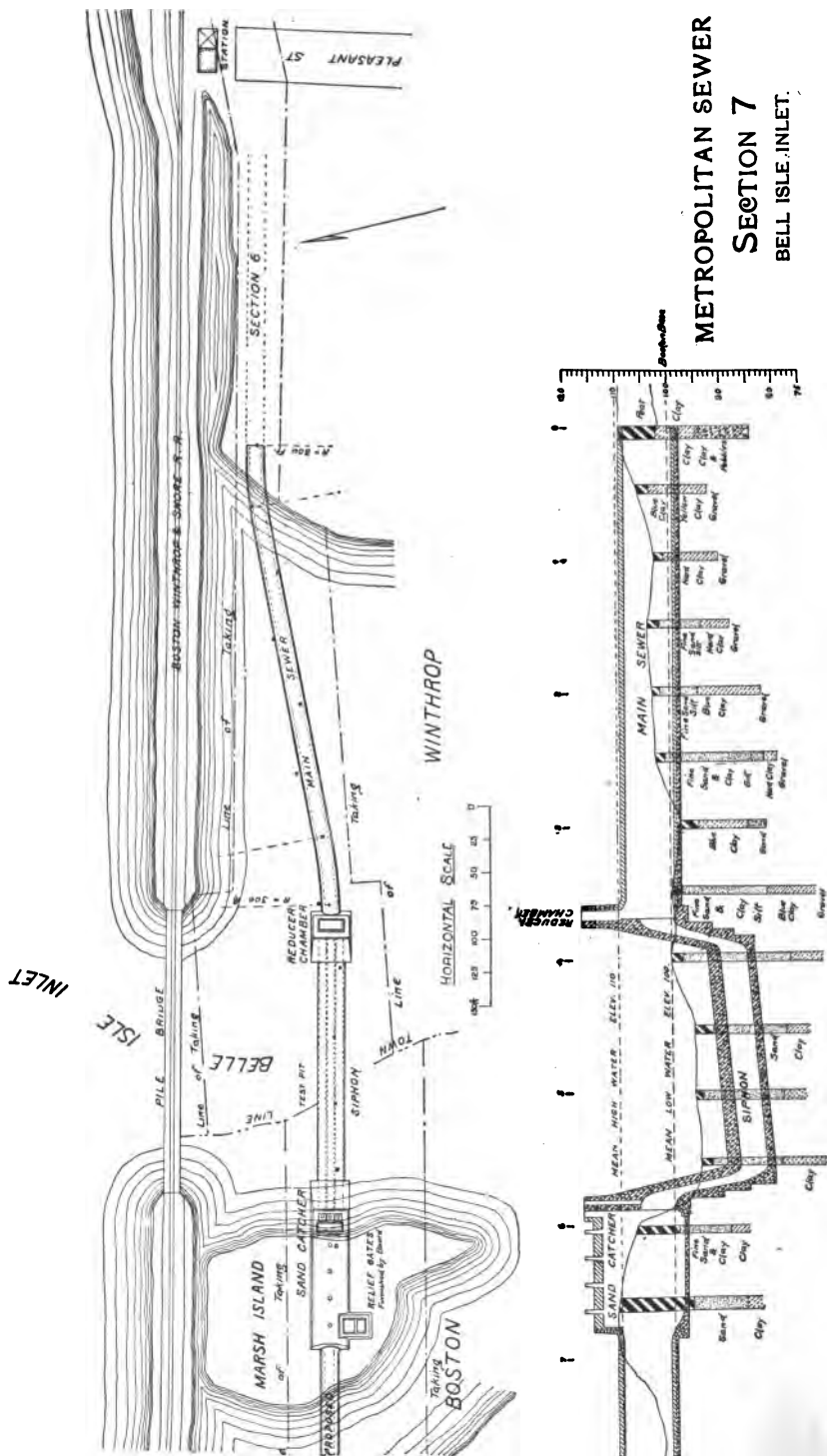
Approximate cost per linear foot of trench and masonry, including relaying of Winthrop pipe sewer, labor, material, inspection and miscellaneous items, ... \$35 70

NOTE.—The information regarding Section 5 following this note relates solely to the year ending Sept. 30, 1892. For a description of the work performed prior to this year, see the second and third annual reports.

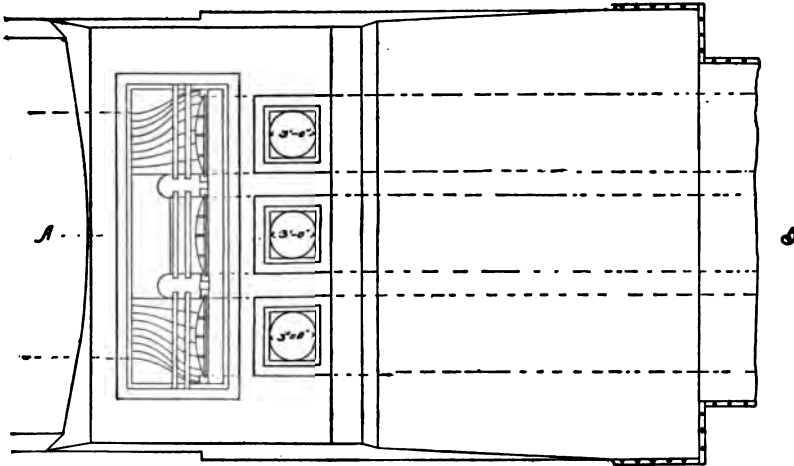
Excavation.—A trench machine was used. Beginning at a point 1,000 feet west of Shirley Station, the work extended 500 feet further in the same direction. An eight-inch pump, together with twelve-inch underdrain, kept the trench free from ground-water. Silt was deposited over all the arch to lessen percolation.

Foundation.—For the whole extent of the work performed this year the sewer rested on piles about 20 feet long, driven in bents, with fourteen-inch by twelve-inch caps and a four-inch platform.

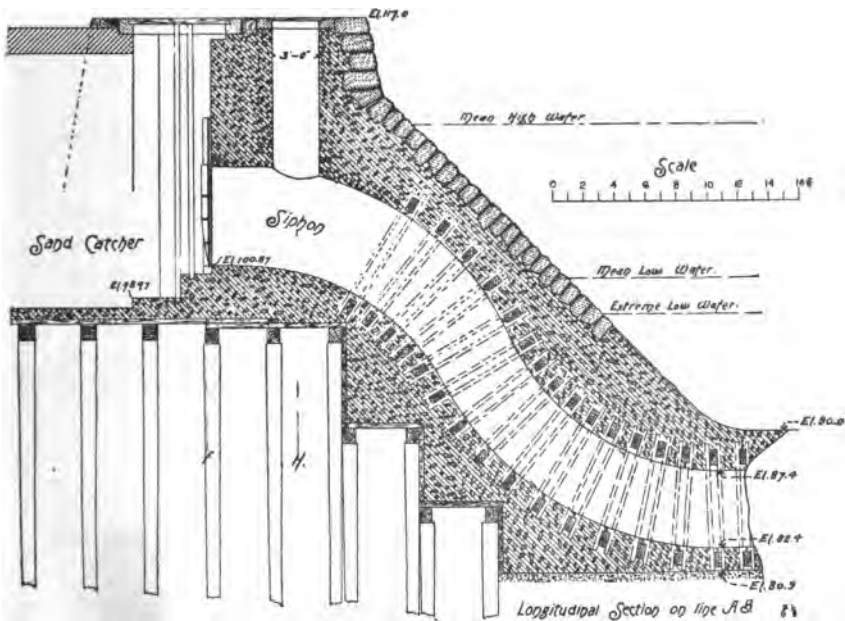
Progress.—One gang was employed, and its ordinary progress per week, with the full force, was 72 feet. The work was carried on without interruption.



METROPOLITAN SEWER
SECTION 7
BELL ISLE INLET.



Plan of Siphon



SECTION 7, WINTHROP AND EAST BOSTON.

Location. — From a point about 300 feet westerly from Pleasant Street Station, on the Boston, Winthrop and Shore Railroad, across Belle Isle Inlet and Marsh Island to a point on the marsh in East Boston about 100 feet easterly from Riverside Avenue.

Length of section, ... 848 feet.

Diameters of sewers, and length of each size: —

Main sewer, horseshoe shape, 8 feet 6 inches by 9 feet 2 inches, ... 516 "

Sand catcher, horseshoe shape, 16 feet by 16 feet 5 inches, ... 84 "

Three parallel lines of five-foot diameter sewer in siphon, pipe chamber and reducer chamber, each, 248 "

Contractors. — Trumbull & Ryan of Boston, Mass.

Contractors' Assistants.

Superintendent, Charles E. Trumbull.

Foreman for construction of coffer-dam, Harris C. Porter.

State Assistants.

Inspectors: R. H. Sumner, Daniel J. Sullivan.

Transitmen: Principal — E. Elbert Young.

" Assistants — William H. Boardman, Jr., Wm. M. Stodder.

Trench.

Length completed, main sewer, ... 381.00 feet.

Length completed, sand catcher and siphon, ... 87.00 "

Average depth of excavation to bottom of trench, sand catcher, ... 14.00 "

Greatest depth of excavation to bottom of trench, sand catcher, ... 15.00 "

Average width top of trench, main sewer, ... 17.30 "

Average width top of trench, sand catcher, ... 30.30 "

Average width bottom of trench, main sewer, ... 17.30 "

Average width bottom of trench, sand catcher, ... 31.10 "

Cubic yards excavation per linear foot, sand catcher, 15.92.

Contract price for whole excavation (including making coffer-dams, etc.), \$34,675.

Character of Earth Excavation. — River mud, fibrous peat, fine sand and soft clay.





HELIOTYPE PRINTING CO., BOSTON

Section 7, Winthrop and East Boston. Work on coffer-dam at Bell Isle Inlet. October 10, 1892.



Masonry.

Contract price:—

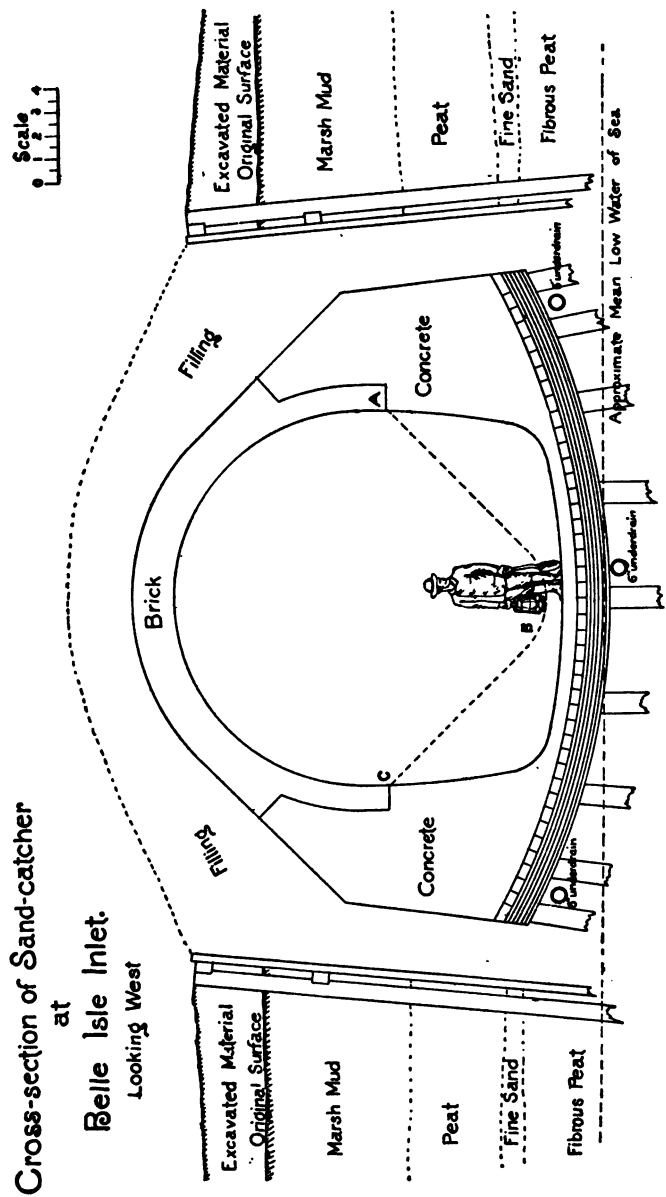
Brick-work, per cubic yard (brick and cement furnished by the Board), ...	\$5 00
Concrete, per cubic yard (gravel and cement furnished by the Board), ...	2 50
Squared-stone, per cubic yard (stone and cement furnished by the Board), ...	3 50
Length completed, ...	370 feet.

Masonry begun, July 28, 1892, and is now in progress.

Excavation, etc.—Derricks have been used for hoisting the excavated earth. A single row of four-inch sheet piling has been driven on each side of the trench for a coffer-dam for the shore ends. Operations were begun July 5, 1892, at both ends of the section. The dam on the Winthrop end was constructed 230 feet towards the centre of the stream, and excavation was completed the same distance. The dam and excavation is now progressing from the East Boston end towards Winthrop.

Water broke into the trench August 5, but did no damage beyond delaying the work one day. At high tide, on the night of August 10, a large leak developed in the sheeting at a point about 35 feet from the beginning of the section on the Winthrop end. The water, being confined between the sheeting and the invert already built, found a way between the brick-work and the concrete, and pushed the brick-work away from the concrete. The leak in the sheeting was caused by removing a brace (to admit of setting centres) and neglecting to first put in another. About 90 feet of brick-work was taken down and relaid to repair the effects of this accident. Very little water has at other times leaked in. A four-inch centrifugal pump is kept on the trench, but is used only about half the time. A ten-inch underdrain was used for the work on the Winthrop side. For 151 feet of the main sewer on the East Boston side a six-inch underdrain has been used, and there are two lines of the same size underdrain in the sand catcher.

Foundation.—For 151 feet on the East Boston side the trench was excavated to an average depth of about 18 inches



below sewer grade and refilled with firm material. Under the sand catcher piles have been driven in bents, 4 feet apart on centres, with piles averaging 32 feet in length. The tops of the piles in each bent have been cut to fit an arc of circle of 30 feet radius. The capping fitted to this arc consists of six pieces of two-inch by twelve-inch spruce placed one over the other, bent to fit the curve, and drift-bolted to each pile with three-fourth-inch diameter bolts. The platform over the caps is of four-inch spruce planks. A cross-section of the sand catcher is shown on an adjacent plate. The dotted line, A, B, C, indicates a temporary trial channel of timber. The shape will be changed, if necessary, after the system is in operation, until a cross-section is found best adapted to retain only gravel and other heavy particles which would otherwise be lodged in the siphon.

Difficulties. — No serious difficulty has been experienced in the work up to this point. It may be stated, however, that the difficult part of this section has not yet been commenced by the contractors. Preparations are making for building a substantial coffer-dam around that portion of the work which passes under the bed of the inlet.

Progress. — One gang of fifty men has been employed. The excavation has sometimes been finished for a short length and then stopped until other work was built. The average progress has been 39 feet per week.

SECTION 8, EAST BOSTON.

Location. — From Belle Isle Inlet through Faxon Street to Butler Avenue, thence along Butler Avenue to Saratoga Street, thence through Saratoga Street, crossing under the Boston, Revere Beach & Lynn Railroad, to about 50 feet beyond the West End Street Railway stables.

Length of section, ... 4,126 feet.

Diameters of sewers, and length of each size: —

Circular, 9 feet by 9 feet 2 inches, ... 3,266 "

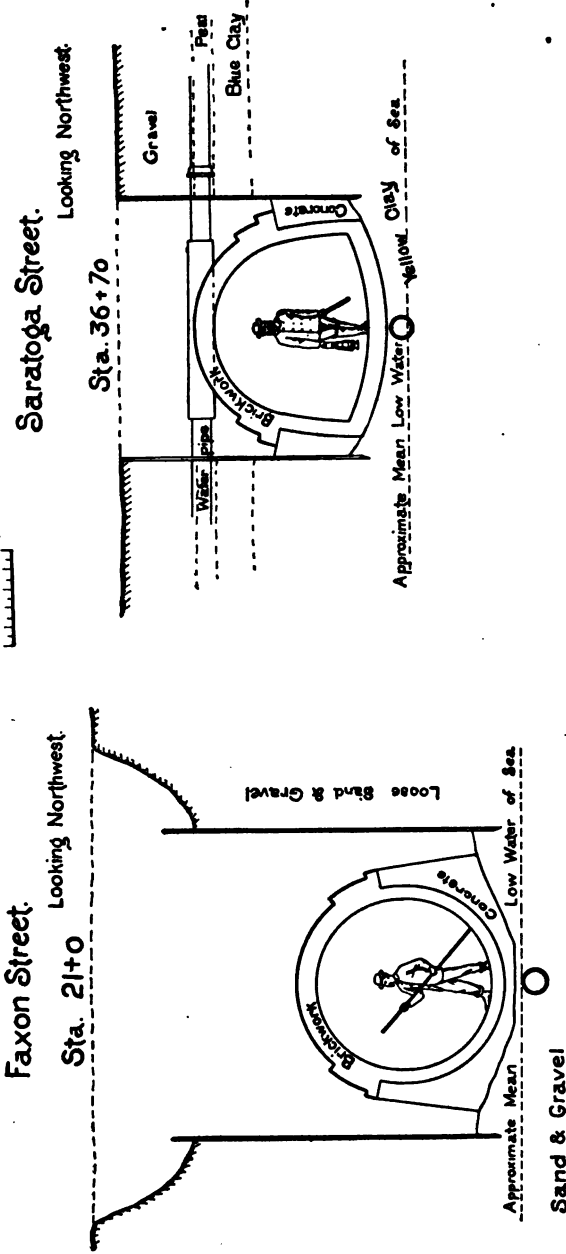
Horse-shoe, 8 feet 6 inches by 9 feet 2 inches, ... 746 "

Modified, to pass under pipes, etc., ... 114 "

Contractor. — Charles Linehan of Cambridge, Mass. Mr. Linehan acted as his own superintendent.

Cross-sections of Trench,
Section 8, East Boston.

Scale
0 10 20 30 ft.



State Assistants (Year ending Sept. 30, 1892).

Inspector: J. H. Etridge.

Transitmen: Principals — Hartley L. White, Francis L. Sellew.

" Assistants — E. S. Foster, A. H. Pratt, E. F. Adams.

Trench.

Length completed, ...	4,126.00 feet.
Average depth of excavation to bottom of underdrain, ...	16.40 "
Greatest depth of excavation to bottom of underdrain, ...	23.00 "
Average width top of trench, ...	16.90 "
Average width bottom of trench, ...	15.20 "
Cubic yards excavation per linear foot, 8.80.	
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below grade, etc., \$8.20.	

Character of Earth Excavation. — From Belle Isle Inlet to Washburn Avenue, peat and clay; from Washburn Avenue to the Boston, Revere Beach & Lynn Railroad, loose sand and gravel, with some clay; from this point to the end, strata of sand, gravel, peat and clay, — the sewer resting upon firm clay.

Masonry.

Contract price: —

Brick-work, American cement mortar, per cubic yard (brick furnished by the Board), ...	\$6 00
Brick-work, Portland cement mortar, per cubic yard (brick furnished by the Board), ...	7 25
Concrete, American cement mortar, per cubic yard, ...	4 00
Concrete, Portland cement mortar, per cubic yard, ...	4 50
Approximate cost of masonry per linear foot, ...	17 40
Length completed, ...	4,126 feet.

Masonry begun, Sept. 4, 1890; finished, June 23, 1892, except scraping of arches inside.

Approximate cost of section per linear foot of trench and masonry, including labor, material, inspection and miscel- laneous items, ...	\$28 00
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NOTE. — The information regarding Section 8 following this note relates solely to the year ending Sept. 30, 1892. For a description of the work performed prior to this year, see the second and third annual reports.

Excavation. — The machinery employed was a steam derrick. Operations extended from the Boston, Revere Beach & Lynn Railroad on Saratoga Street, along Saratoga Street to Butler Avenue, and through Butler Avenue to Faxon Street, and along this street for 500 feet. A six-inch

pump placed at a pump-well near Washburn Avenue on Faxon Street, together with six-inch and ten-inch under-drain, kept the trench clear of ground-water from the beginning to the corner of Butler Avenue and Faxon Street.

Foundation. — The bottom of the trench was sufficiently firm to allow of excavating to fit the invert of the sewer.

Accidents. — There were a few slight accidents to men, but no permanent injuries were sustained by any one.

Progress. — Most of the time two gangs were employed. The ordinary progress per week, with a complete gang working, was 30 feet. The work was not permanently shut down after it was started, but the contractor many times temporarily abandoned openings for irregular intervals. During severe winter weather very little was done.

SECTION 9, EAST BOSTON.

Location. — From a point on Saratoga Street 50 feet west of the West End Street Railway car stables, through Saratoga Street to its junction with Addison Street, thence through Addison Street, passing under the old Eastern Railroad, to a point about 350 feet east of Chelsea Street.

Length of section, ... 3,383 feet.

Diameters of sewers, and length of each size: —

Circular, 9 feet by 9 feet 2 inches, ... 2,018 "

Horseshoe, 8 feet 6 inches by 9 feet 2 inches, ... 1,365 "

Contractor. — Charles Linehan of Cambridge, Mass. Mr. Linehan acted as his own superintendent.

State Assistants (Year ending Sept. 30, 1892).

Inspectors: J. H. Etridge, M. F. Garra, E. A. Clark, G. A. Chase, H. B. Damon.

Transitmen: Principals — Hartley L. White, Francis L. Sellow.

" Assistants — E. S. Foster, A. H. Pratt, E. F. Adams.

Trench.

Length completed, ... 3,383.00 feet.

Average depth of excavation to bottom of concrete, ... 15.80 "

Greatest depth of excavation to bottom of concrete, ... 24.50 "

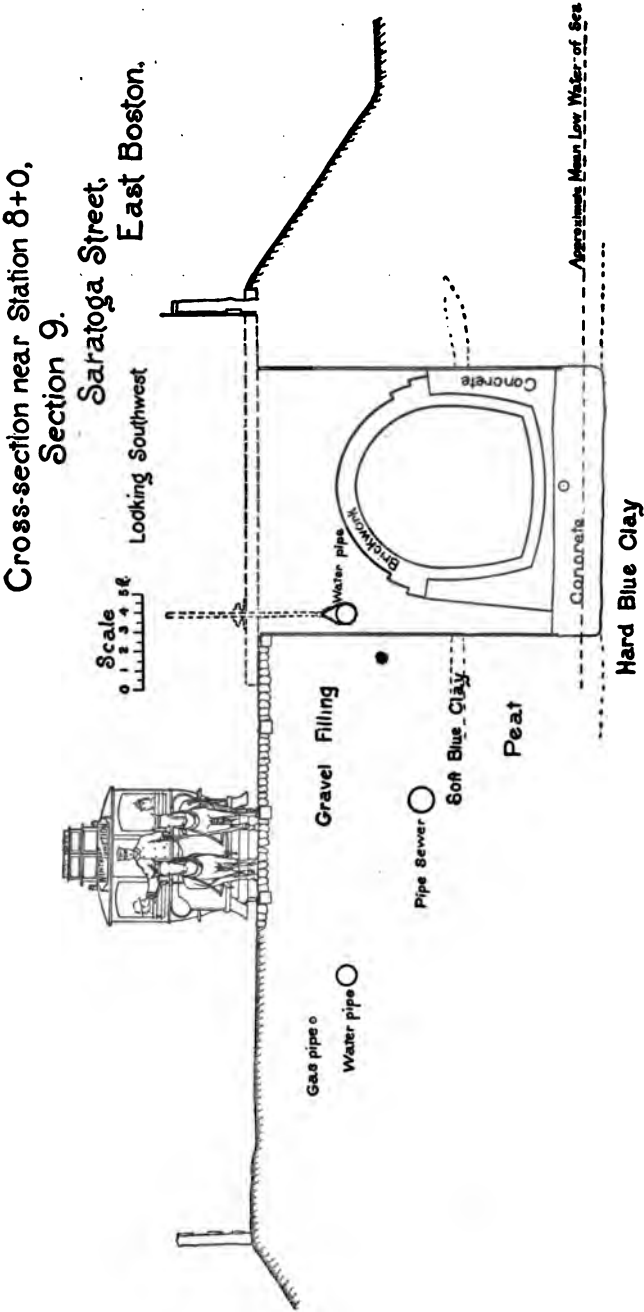
Average width top of trench, ... 12.60 "

Average width bottom of trench, ... 12.60 "

Cubic yards excavation per linear foot, 6.50

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below grade, etc., \$8.40.

Character of Earth Excavation. — For first 1,400 feet through gravel and peat to firm clay, the remainder through clay and hard-pan.



Masonry.

Contract price:—

Brick-work, American cement mortar, per cubic yard (brick furnished by the Board), ...	\$6 00
Brick-work, Portland cement mortar, per cubic yard (brick furnished by the Board), ...	7 25
Concrete, American cement mortar, per cubic yard, ...	4 25
Concrete, Portland cement mortar, per cubic yard, ...	5 25
Approximate cost of masonry per linear foot, including under-drain, etc., ...	17 90
Length completed, ...	3,383 feet.

Masonry begun, Oct. 1, 1890; finished, June 24, 1892, except scraping of arches inside.

Approximate cost of section per linear foot of trench and masonry, including labor, material, inspection and miscellaneous items, ... \$30 20

NOTE.—The information regarding Section 9 following this note relates solely to the year ending Sept. 30, 1892. For a description of the work performed prior to this year, see the second and third annual reports.

Excavation.—For a distance of about 900 feet on Saratoga Street a trench machine was used. For about 250 feet at the upper end of the section, on Addison Street, where the cut was light, the material was thrown out by hand. A four-inch Andrews pump and fifteen horse-power Hoadley engine were used for three months at Saratoga Street culvert. For the balance of the section one, and sometimes two, Edson diaphragm hand pumps were used. The upper end of the section was practically dry. Six-inch underdrain was used on Saratoga Street. A gravel drain was used on Addison Street.

Foundation.—For about 250 feet on Addison Street the bottom of the trench was excavated to fit the invert of the sewer. From the beginning of the section to near the junction of Saratoga and Addison streets peat and silt were excavated to a depth of from $\frac{1}{2}$ foot to $6\frac{1}{2}$ feet below sewer grade, and a bed of concrete was placed upon the underlying clay for a foundation for the sewer.

Difficulties.—The sewer passed under the old Eastern Railroad, and at this point the arch was reinforced with concrete. About 500 feet west of the West End Street Railway horse-car stables a culvert for the passage of tide-water, having originally a diameter of 5 feet by 6 feet, was

somewhat modified in shape, according to plans approved by the Harbor Commissioners, and carried under the Metropolitan sewer. A new mouth at the inland end of the culvert was built of stone masonry of a character superior to that which it replaced.

Progress. — Two gangs were employed until Dec. 15, 1891, after which time there was but one. With complete gangs working, the ordinary progress at the lower opening was 40 feet per week, and at the upper opening 60 feet. There were no interruptions, but the work proceeded very slowly.

Miscellaneous. — For a length of 450 feet at the upper end of the section an embankment was built over the sewer, varying in height from 5 to 7 feet above marsh level. As tide-water reached this embankment, its water side was protected by paving.

SECTION 10 (DAY WORK), EAST BOSTON AND CHELSEA.

Location. — From the site of the proposed pumping station at East Boston, near the Grand Junction Railroad bridge over Chelsea Creek, thence under Chelsea Creek between the Grand Junction Railroad bridge and the Chelsea Street road bridge to a point on Marginal Street near Eastern Avenue, in Chelsea, where connection is made with Section 12.

Approximate length of section, ... 660 feet.

Assistants.

Foreman on tunnel work: Charles A. Haskin.

Transitmen: Principal — E. Elbert Young.

“ Assistant — William H. Boardman, Jr.

Proposed Work. — On the 26th of this month the ground was broken for a tunnel shaft at a point about 25 feet south of the Grand Junction Railroad track in East Boston. A second tunnel shaft will be started on the Chelsea side. Work from the two headings will proceed towards the centre of the stream, but should this tunnel work prove by trial to be too costly, other methods may be used instead. As actual operations may develop the necessity for a change in the plan of operations, as above noted, and as provisions for such changes cannot well be arranged in contracts, it was thought best to begin operations by day work.

SECTION 12, CHELSEA.

Location. — From Marginal Street near Eastern Avenue along Marginal Street to Shawmut Street.

Length of section, ... 3,024 feet.

Diameters of sewer, 8 feet 4 inches by 9 feet 2 inches.

Contractor. — Orin P. Roberts of Cambridge, Mass.

Contractors' Superintendent. — Charles G. Craib.

State Assistants (Year ending Sept. 30, 1892).

Inspectors: M. F. Garra, H. H. Marden, Jr., Samuel P. McKenzie, Francis L. Sellew, James E. Coyne.

Transitmen: Principals — Hartley L. White, Seth Peterson.

“ Assistants — Charles Kincaid, Alfred D. Allen, T. T. Cass, Edward S. Foster, J. J. Comfrey.

Trench.

Length completed, ... 2,402.00 feet.

Average depth of excavation to bottom of pile cap (no

underdrain for most of this section), ... 27.00 “

Greatest depth of excavation to bottom of pile cap, ... 28.50 “

Average width top of trench, ... 14.60 “

Average width bottom of trench, ... 12.60 “

Cubic yards excavation per linear foot, 13.60.

Approximate cost of trench per linear foot, including four-inch tongued and grooved sheeting left in, excavation and refilling below grade, etc., \$16.

Character of Earth Excavation. — Strata of gravel, peat, silt and fine sand.

Masonry.

Contract price: —

Brick-work, American cement mortar, per cubic yard, . . . \$13 36

Brick-work, Portland cement mortar, per cubic yard, . . . 14 41

Concrete, American cement mortar, per cubic yard, . . . 5 00

Concrete, Portland cement mortar, per cubic yard, . . . 6 35

Approximate cost of masonry per linear foot, including pile,

platform, underdrain and gravel filling around sewer, . . . 28 00

Length completed, ... 2,237 feet.

Masonry begun, Aug. 4, 1891, and is now in progress.

Approximate cost of section per linear foot of trench and masonry,

including test pits, pipe-wells, labor, material, inspection

and miscellaneous items, ... \$47 10

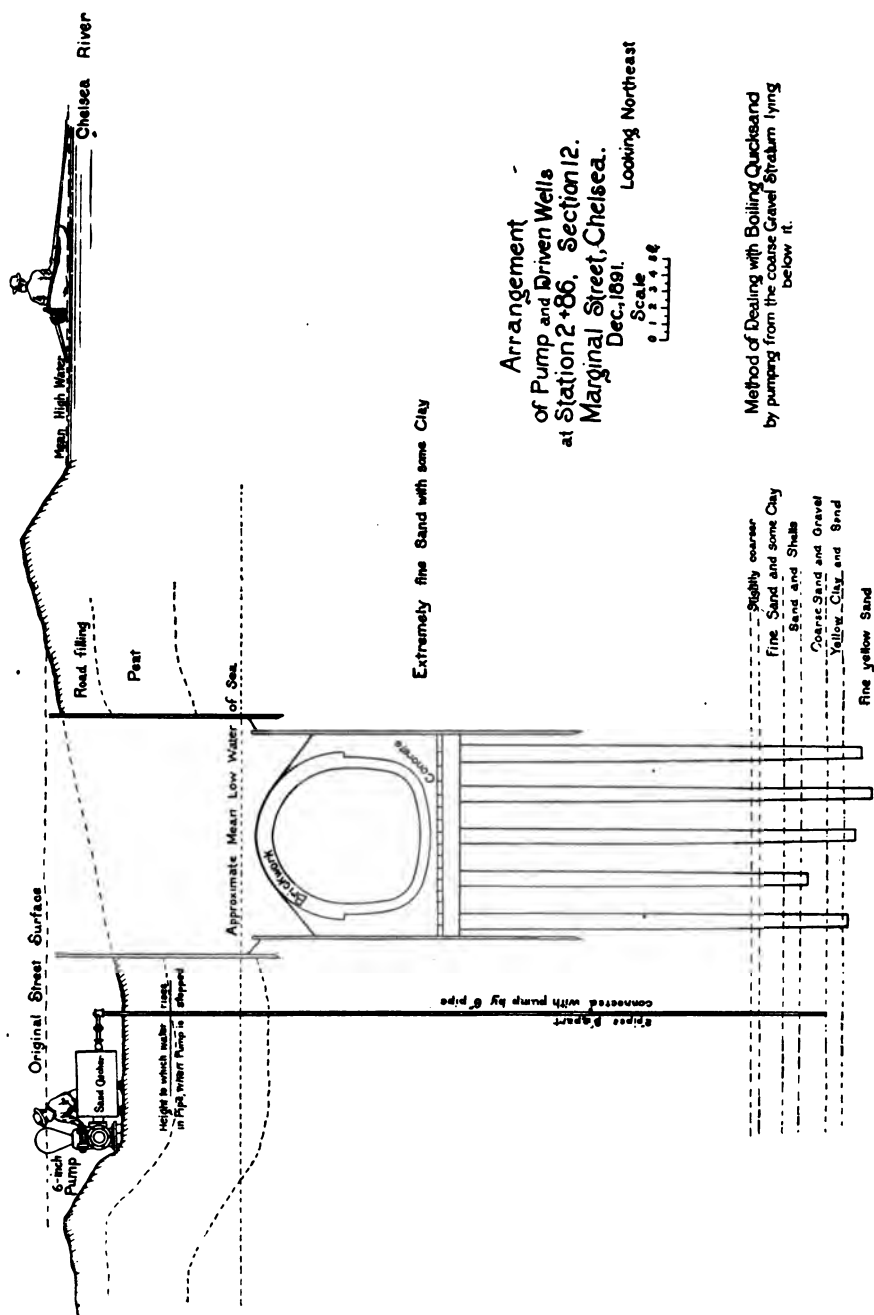
NOTE. — The information regarding Section 12 following this note relates solely to the year ending Sept. 30, 1892. For a description of the work performed prior to this year, see the third annual report.



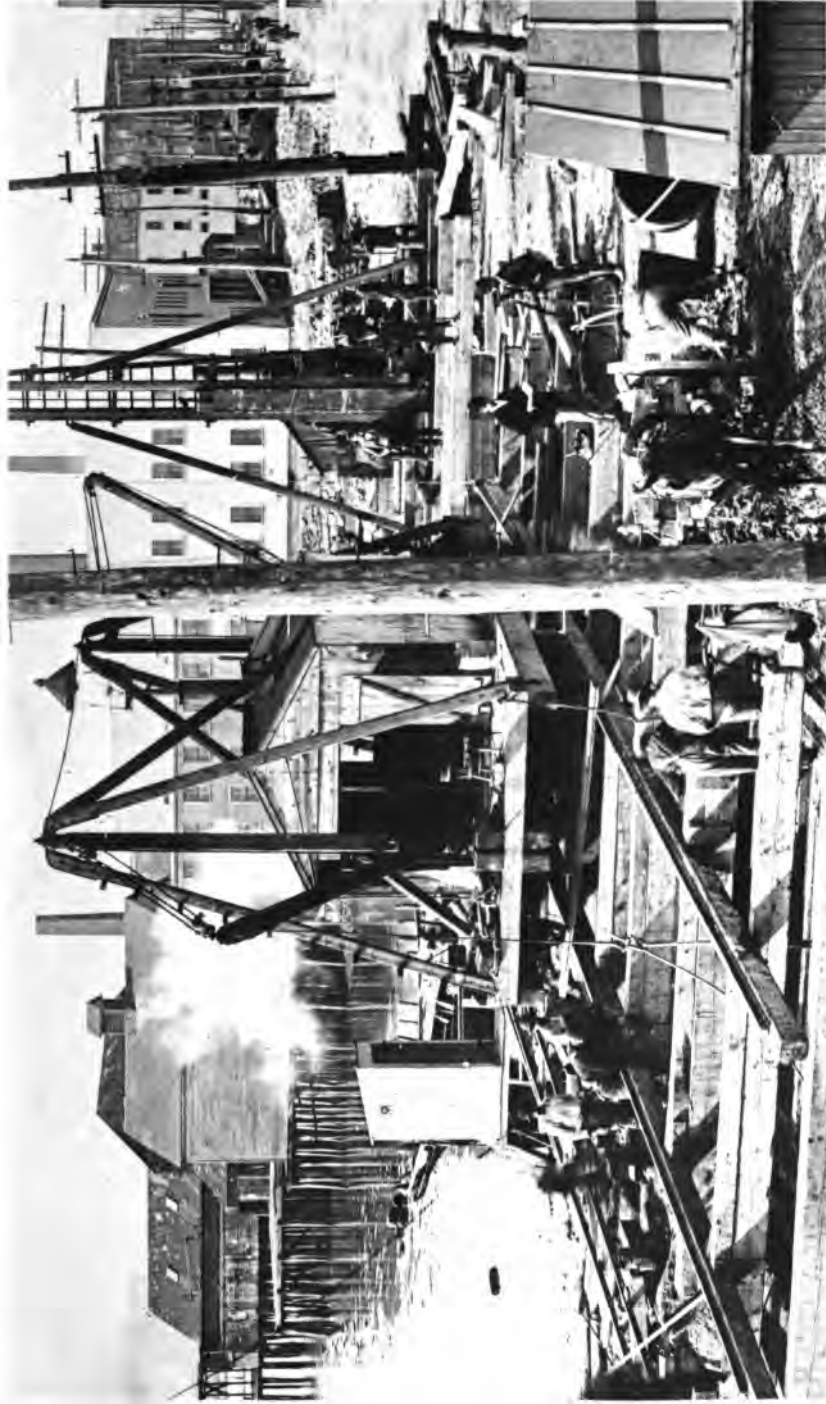
Section 12, Marginal Street, near Charles Street, Chelsea. August 16, 1892.

HELIOTYPE PRINTING CO., BOSTON





Excavation. — The earth was hoisted at the lower end of the section this year by means of derricks. Work from the beginning of the section has now reached a point about 150 feet east of Highland Street. At this street a second opening was made April 12 with a trench machine, and operations have proceeded to a point about 200 feet beyond Charles Street. The difficulties with boiling quicksand, described in my report for last year, continued during the fall of 1891. On November 4, after serious delay and expense, the contractor had a section of platform completed near Congress Avenue, supported on capping and piles. Quicksand had covered the platform. For eight days the contractor's gang worked, endeavoring to remove the quicksand from the platform, but at the end of this time the depth on the platform was greater than when they began. The trench was almost filled with bracing which from time to time had necessarily been put in, and was in a very demoralized condition. Borings revealed the fact that at a distance of 22 feet below the bottom of the sewer there was a stratum of gravel containing water. The stratum was doubtless inclined and extended to more or less distant elevations. The water in the stratum was under pressure, and rose in an open-ended tell-tale pipe to within about 7 feet of the surface of the street, or about 20 feet above the bottom of the excavation. This water, seeking an outlet, came up through the very fine earth, causing boiling springs of quicksand. It was suggested to the contractor that the difficulty could perhaps be cured by sinking pipes into the gravel and lowering the head of water to a point below the excavation. The contractor, however, disheartened by the great expense and trouble that he had already had, did not care to go to any further expense in trying an experiment. He had taken the work at a low price, and prosecuted it with energy and perseverance. If he abandoned the contract it would cause serious delay and loss to the State. If the experiment was successful, the method could be used to advantage at other points on the system. It was therefore recommended that pipes be sunk on that section at the expense of the State. The plan was approved by your Board, and proved entirely successful. The wells were sunk about 8 feet apart at first, and



HELIOTYPE PRINTING CO., BOSTON

Section 12, Marginal Street, near Highland Street, Chelsea. October 15, 1892.





Section 12, Marginal Street, Chelsea. Settlement of trench on account of quicksand. Pipe-wells for tapping water-bearing stratum below quicksand. December 17, 1891.

later at greater distances. When eight of these had been put in they were capped and connected together, and also to a six-inch Blake pump. Within twenty-four hours after pumping on these pipes began, the water in the trench which had leaked in from the sea was pumped out, and it was found that the boiling springs had entirely ceased. The quicksand which covered the platform alluded to above was removed without any difficulty whatever. This method was pursued from near Congress Avenue for a distance of 1,400 feet, and fifty wells were driven before the bottom could be exposed without danger of demoralization. For the whole length of this difficult work tongued and grooved sheet piling was driven on both sides of the trench, to secure its stability. No further trouble from boiling springs and quicksand has occurred on this section during the year, except once or twice when the experiment was tried of stopping pumping on the pipe wells. Similar difficulty with quicksand has occurred on various other parts of our work, and has been successfully treated in a similar manner by the contractors. A section illustrating the foregoing is shown on an adjoining plate.

Foundation.—For a distance of 60 feet near Charles Street the bottom of the trench has been excavated to fit the invert of the sewer. For a distance of 115 feet near Highland Street silt was excavated to an average depth of 2 feet below sewer grade, and gravel filling placed upon the underlying clay. From near Congress Avenue to Highland Street the sewer was built upon a platform supported upon bents of piles 4 feet apart, five in a bent. Piles varying in length from 6 to 32 feet were used.

Difficulties.—The principal difficulties have been those mentioned in connection with excavation. At extreme high tide the trench has several times been flooded, and at a point about 600 feet from the beginning it was necessary to build a timber dam along the outside of the sea wall to prevent the influx of the tide.

Accidents.—The injury to a portion of the sewer, caused by quicksand, was mentioned in last year's report. Several brick buildings built without special foundation upon the silt were somewhat settled and cracked during this year's work,

but they have been satisfactorily repaired. The following accidents to men are reported: a laborer in the trench was struck by a falling plank; one of the pile-driving gang, while climbing out of the trench, fell and broke his leg.

Progress. — With two complete gangs working, the ordinary progress per week at the upper opening has been 37 feet, and at the lower opening 60 feet. Very little was done during the winter, but the work was not shut down.

SECTION 14, CHELSEA.

Location. — From a point in Marginal Street 40 feet west of Shawmut Street, through Marginal Street to Hawthorn Street, thence on the line of Marginal Street extended for 200 feet through private land to near Pearl Street, thence through private land to Chelsea Square, thence through Second Street to a point about 100 feet north-west of Spruce Street.

Length of section, ... 3,445 feet.

Diameters of sewers and length of each size: —

8 feet 10 inches (circular), ...	2,134 "
8 feet 4 inches by 9 feet 6 inches, ...	91 "
8 feet 4 inches by 9 feet, ...	1,110 "
8 feet 2 inches by 8 feet 10 inches, ...	110 "

Contractors. — Metropolitan Construction Company of Boston, Mass.

Contractors' Superintendent. — George W. Judd.

State Assistants.

Inspectors: M. F. Garra, John D. Collins, James J. Conway, Frank M. Sherman.

Transitmen: Principal — Seth Peterson.

" Assistants — Charles Kincaid, T. T. Cass.

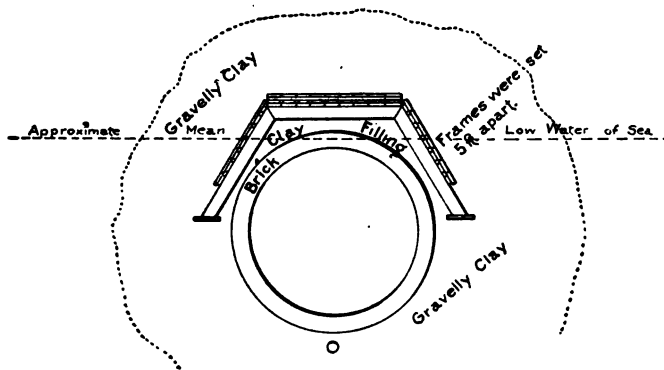
Trench and Tunnel.

Length completed of trench excavation, ...	1,102.00 feet.
Length completed of tunnel excavation, ...	1,061.00 "
Average depth of trench excavation to bottom of underdrain, ...	29.00 "
Greatest depth of trench excavation to bottom of underdrain, ...	37.00 "
Average width top of trench, ...	14.00 "
Average width bottom of trench, ...	12.00 "
Average depth from surface of ground to bottom of tunnel underdrain, ...	37.00 "
Greatest depth from surface of ground to bottom of tunnel underdrain, ...	45.50 "
Average width of tunnel, ...	11.00 "



Cross-section of Tunnel.
Cor. Park & Winnisimmet Sts.,
Section 14, Chelsea.

Scale
0 1 2 3 4 5 ft.



Cubic yards trench excavation per linear foot, 12.30.

Cubic yards tunnel excavation per linear foot, 4.20.

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below grade, etc., \$25.90.

Approximate cost of tunnel per linear foot, \$28.

Character of Earth Excavation. — Clay and gravelly clay, with occasional pockets of sand and quicksand.

Masonry.

Contract price: —

Brick-work, American cement mortar, per cubic yard, trench, .	\$12 11
Brick-work, American cement mortar, per cubic yard, tunnel, .	13 94
Brick-work, Portland cement mortar, per cubic yard, trench, .	14 06
Brick-work, Portland cement mortar, per cubic yard, tunnel, .	16 00
Concrete, American cement mortar, per cubic yard, trench, .	4 92
Concrete, American cement mortar, per cubic yard, tunnel, .	5 98
Concrete, Portland cement mortar, per cubic yard, trench, .	6 88
Concrete, Portland cement mortar, per cubic yard, tunnel, .	9 25
Approximate cost of masonry per linear foot of trench, including underdrain, etc., ...	17 90
Approximate cost of masonry per linear foot of tunnel, including underdrain, etc., ...	18 40
Length completed, trench, ...	993 feet
Length completed, tunnel, ...	1,010 "

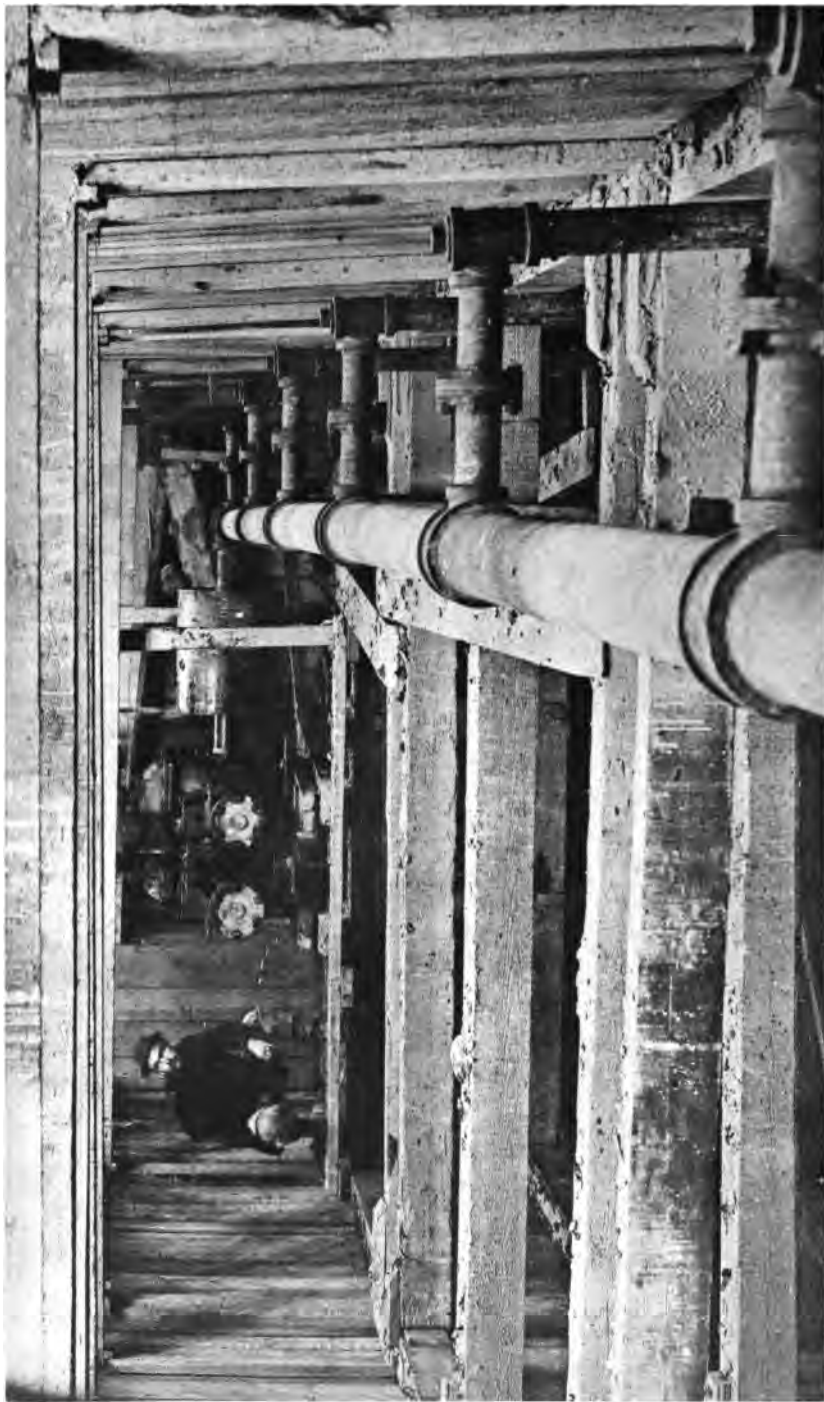
Masonry begun in tunnel, April 14, 1892, and is now in progress.

Masonry begun in trench, June 2, 1892, and is now in progress.

Approximate cost of section per linear foot of excavation and masonry, including relaying Chelsea sewer, labor, material, inspection and miscellaneous items, ... \$45 60

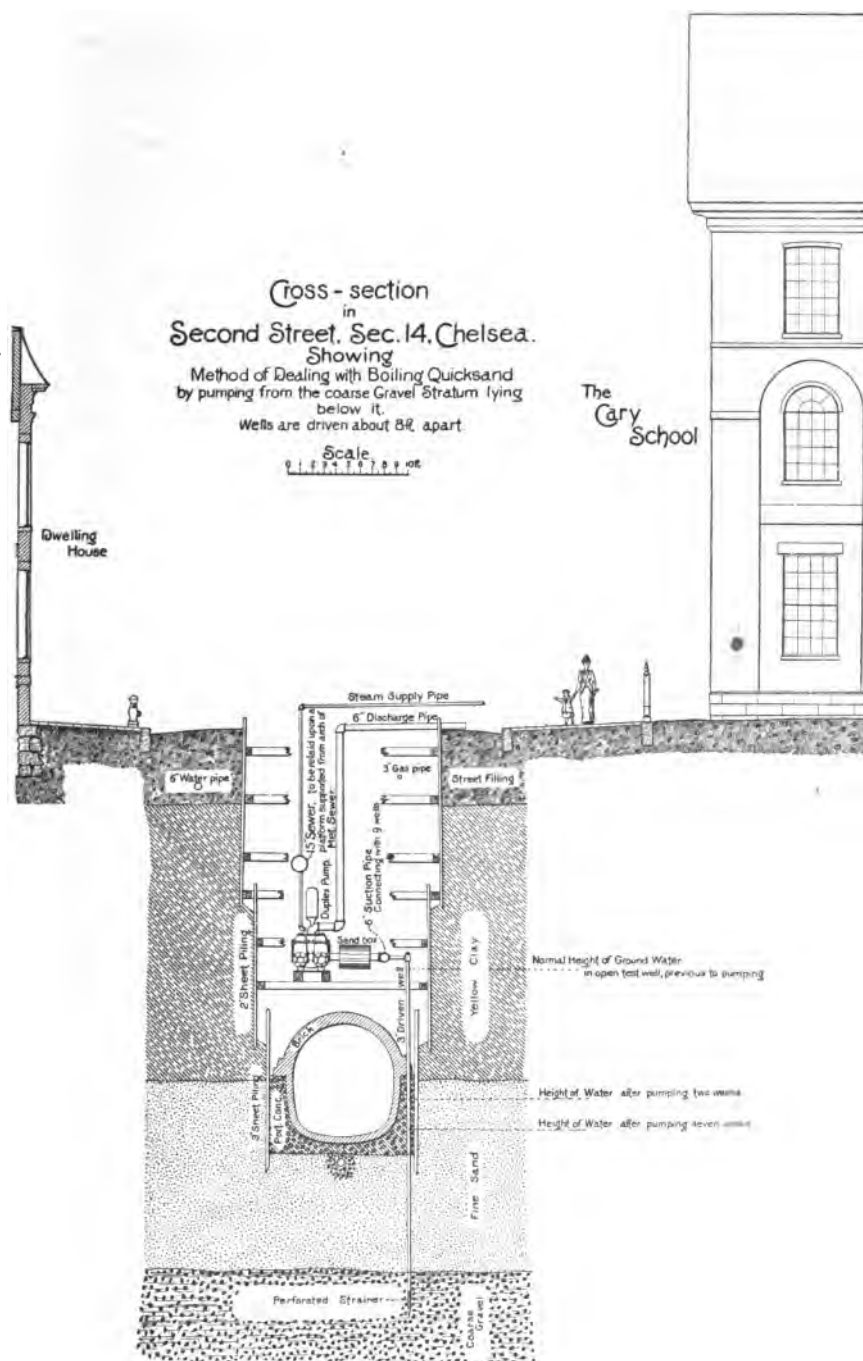
Excavation, etc. — A trench machine has been used for the open cut work, and tram cars and cages for tunnel excavation. A shaft near Pearl Street was begun March 29, 1892, and one was started in Chelsea Square May 24, 1892. Open cut work near Spruce Street was commenced May 25, 1892. The principal portion of the excavation now to be done is about 670 feet in Marginal Street at the beginning of the section and about 690 feet of very difficult work in Second Street and Chelsea Square. A moderate quantity of water only has been encountered in the tunnel excavation east of the shaft in Chelsea Square. A ten-inch underdrain was used for some distance, and later one of six inches in diameter. The excavation in the trench at Spruce Street

H. P. V.



HELIOTYPE PRINTING CO., BOSTON

Section 14, Second Street, Chelsea, near the Cary School. Pipe-wells for tapping water-bearing stratum below quicksand. September 6, 1892.



was in gravel, where a large volume of water was encountered. Two pump wells were sunk in the vicinity, and pumping was carried on continuously with eight-inch centrifugal pumps. One hundred feet from Spruce Street the excavation entered clay, and from there to Ash Street comparatively little water was found in the trench. Opposite the school-house at Walnut Street the lower part of the trench excavation was in very fine sand, and boiling springs similar to those of Section 12 were encountered. The natural head of this water was some 14 feet above the bottom of the excavation, and tubular wells similar to those used on Section 12 were driven by the contractors. Some of the facts concerning these wells are shown on an adjacent plate. At this date (September 30) there are nine wells in operation, and they are connected with pumps delivering about 300,000 gallons per twenty-four hours. This water is lifted about 32 feet. The pumping has reduced the head of water to about 3 feet above water line. Additional wells and pumps will be put in, and it is expected that the water will be lowered so that the sewer may be completed in this vicinity without causing other than trifling injuries to adjacent buildings. The underdrain used in the trench has been four, six, ten and twelve inch.

Difficulties.—The quicksand alluded to above as encountered in Second Street has been the principal obstacle to progress. On account of the great depth of the trench in this street, — 37 feet at Chestnut Street, — great care and skill was required in bracing. From Spruce Street to the end of the section a twelve-inch city sewer was replaced upon the gravel filling which covered the Metropolitan sewer. Again from Spruce Street to Chestnut Street twenty-four, eighteen and fifteen inch pipe sewers have been laid in the trench, upon a gravel or platform foundation. These, by permission of the city engineer, replace an old twenty-four-inch by thirty-inch brick sewer. A constant flow of water in the local sewer has been maintained. The dry-weather flow has been taken care of by an iron pipe, but during storms the increased flow from the sewer was allowed to fill the trench.

Foundation.—The bottom of the excavation has been shaped to fit the invert of the sewer for the whole distance

C.F.V.
H.



Section 14, under Pearl Street, Chelsea. Connection between two tunnel drifts. May 12, 1892

built, viz., 2,003 feet, excepting a length of 93 feet at Spruce Street and 91 feet near Poplar Street.

Accidents. — The trench operations have caused some houses on Second Street, including a large brick school-house, to settle slightly and show fine cracks. The school-house is safely supported by timber blocking and screw jacks.

Progress. — Five gangs have been employed. The ordinary progress per week in the tunnel (two headings) has been about 30 feet. The ordinary progress per week in open cut work has been about 48 feet. Incandescent electric lights have been used in the tunnel, and operations are carried on day and night.

Miscellaneous. — At the start from the Pearl Street shaft, and for 300 feet, the full bore of the tunnel was excavated to exactly fit the brick-work, and the upper part was secured by one-eighth-inch curved steel plates, made in lengths of 3 feet and 1 foot in width, which were bolted to each other and were supported by eight-inch by eight-inch temporary timber posts. These supporting timbers were gradually removed as the masonry of the arch progressed. Later the plate method was abandoned by the contractors, and timber sets were substituted. The centre lines between the two shafts met each other within three-sixteenths of an inch, although but short base lines could be had, and a direct surface sight from one shaft to the other could not be obtained. For a distance of 91 feet near Poplar Street, where the sand was inclined to be troublesome, the bottom thickness of the invert was increased to 20 inches of masonry. The least depth from the surface to the sewer arch is 12 feet, at Spruce Street. • Surplus earth from the sewer has been used by adjacent property owners for filling upon marsh lands.

SECTION 15, CHELSEA.

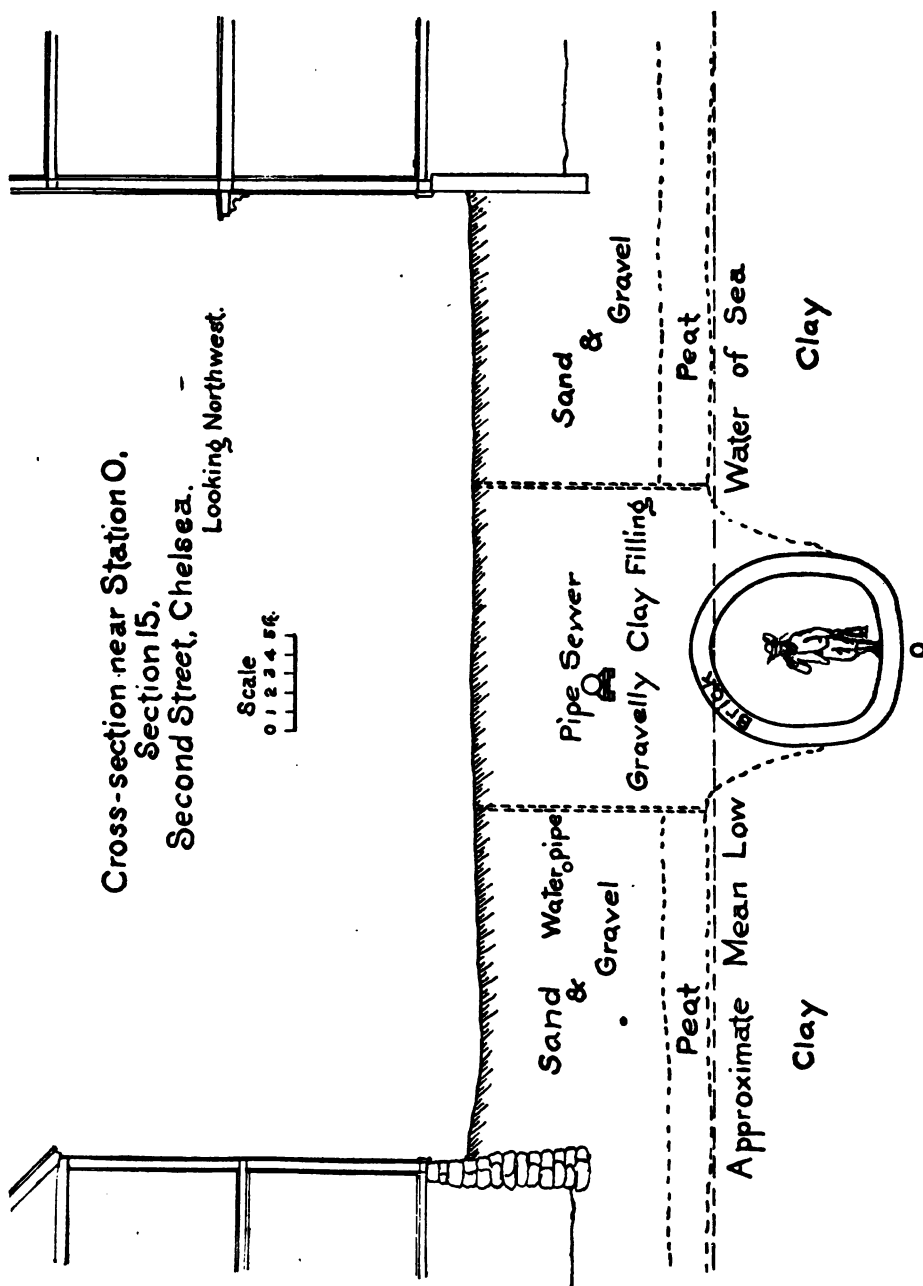
Location. — From near the corner of Spruce and Second Streets through Second Street to the Everett line near Locust Street.

Length of section, ... 1,754 feet.

Diameter of sewer, 8 feet 2 inches by 8 feet 10 inches.

Contractor. — Christy McBride of Brighton, Mass.

Contractor's Superintendent. — Neil McBride.



State Assistants (Year ending Sept. 30, 1892).

Inspectors: E. A. Clark, Samuel P. McKenzie.

Transitmen: Principals — Seth Peterson, Warren A. Rogers.

" Assistants — Charles Kincaid, Alfred D. Allen.

Trench.

Length completed, ...	1,754.00 feet.
Average depth of excavation to bottom of gravel filling, ...	23.20 "
Greatest depth of excavation to bottom of gravel filling, ...	26.50 "
Average width top of trench, ...	14.00 "
Average width bottom of trench, ...	12.50 "
Cubic yards excavation per linear foot, ...	11.30.
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below grade, etc., ...	\$11.75.

Character of Earth Excavation. — Through strata of gravel and peat to firm clay.

Masonry.

Contract price: —

Brick-work, American cement mortar, per cubic yard, ...	\$13 45
Brick-work, Portland cement mortar, per cubic yard, ...	14 50
Concrete, American cement mortar, per cubic yard, ...	5 00
Concrete, Portland cement mortar, per cubic yard, ...	6 50
Approximate cost of masonry per linear foot, including under-drain, etc., ...	18 80
Length completed, ...	1,754 feet.

Masonry begun, Sept. 25, 1891; finished, July 20, 1892.

Approximate cost of section per linear foot of trench and masonry, including labor, material, inspection and miscellaneous items, ... \$32 50

NOTE. — The information regarding Section 15 following this note relates solely to the year ending Sept. 30, 1892. For a description of the work performed prior to this year, see the third annual report.

Excavation. — A trench machine was used throughout. There were four pump wells, placed about 400 feet distant from each other. A six-inch centrifugal pump was used for the most part, and there were used at Cypress Street, both a six-inch and eight-inch pump. About 400 feet of eight-inch and 1,350 feet of ten-inch underdrain was employed in connection with the above. For its whole length the arch was covered with a mixture of clay and gravel.

Foundation. — For a length of 250 feet in the beginning the character of the foundation was such as admitted of its being excavated to fit the invert of the sewer. For a distance of 380 feet from Maple Street towards Cypress Street, peat or silt extended below the bottom of the sewer to a depth of from 0 to 5.5 feet and from near Cypress Street to the end, about 450 feet, it reached from 0 to 8 feet below. This unstable material was removed and replaced with that of a firmer character.

Accidents. — A few minor injuries were sustained by men. Five houses settled, and were later raised by the contractor. During the winter small quantities of frozen brick-work were replaced.

Progress. — The ordinary progress of the one gang employed was, under favorable conditions, about 55 feet per week.

Miscellaneous. — No city sewers were relaid directly upon the arch of the Metropolitan sewer, but two of them were relaid upon gravel filling varying from 1 to 6 feet in depth. One hundred feet of twelve-inch, 275 feet of eight inch, and 330 feet of ten-inch pipe sewer were thus laid, replacing an old wooden box sewer. All surplus earth from the sewer was placed upon low land for filling.

SECTION 16, EVERETT.

Location. — In Second Street, from the Chelsea line to the tracks of the Eastern Division of the Boston & Maine Railroad, thence westerly on the south side of the tracks for about 1,700 feet, thence across the marsh to Broadway near the northerly end of Bow Street.

Length of section, ... 4,432 feet.

Diameters of sewers, and length of each size: —

8 feet 2 inches by 8 feet 10 inches, ... 3,588 "

5 feet 10 inches by 6 feet 4 inches, ... 844 "

Contractors. — R. A. Malone & Son of Philadelphia, Pa.

Contractors' Superintendent. — R. J. Malone.

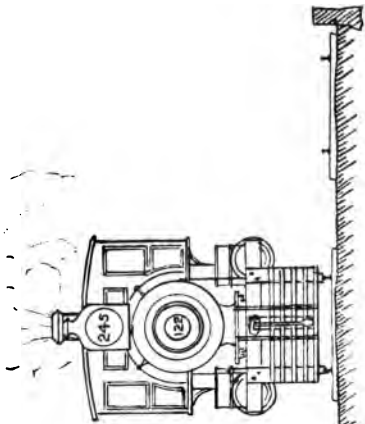
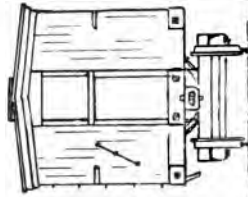
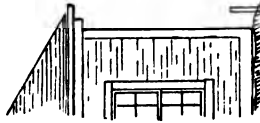
State Assistants (Year ending Sept. 30, 1892).

Inspectors: Samuel Corning, M. F. Garra, Warren A. Rogers.

Transitmen: Principals — Seth Peterson, Paul W. Rowell, Warren A. Rogers.

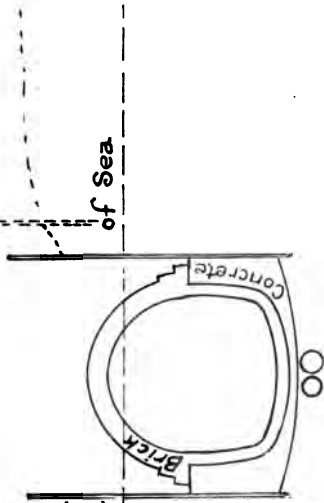
" Assistants — Fred Brett, Charles Kincaid, George E. Howe, G. H. Chase, Alfred D. Allen, George R. Winslow.

Scale
0 1 2 3 4 5 ft



Sand,
Clay
& Gravel

Cross-Section
near
Station 7, Section 16
at
R.R. Station, East Everett.
Looking Northwest



Approximate Mean Low Water

Sandy Clay



Trench.

Length completed, larger size, 2,398 feet; smaller size, 828 feet, ...	3,226.00 feet.
Average depth of excavation to bottom of underdrain, larger size, ...	19.00 "
Average depth of excavation to bottom of underdrain, smaller size, ...	20.00 "
Greatest depth of excavation to bottom of underdrain, both sizes, ...	25.00 "
Average width top of trench, larger size, ...	14.80 "
Average width top of trench, smaller size, ...	10.10 "
Average width bottom of trench, larger size, ...	13.80 "
Average width bottom of trench, smaller size, ...	9.50 "
Cubic yards excavation per linear foot, larger size, 9.10.	
Cubic yards excavation per linear foot, smaller size, 6.50.	
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below grade, etc. : —	
For 8 feet 2 inches by 8 feet 10 inches sewer, \$14.00.	
For 5 feet 10 inches by 6 feet 4 inches sewer, \$8.75.	

Character of Earth Excavation. — Sand, gravel, peat and clay. Throughout most of its length the sewer rests upon firm clay or sandy clay.

Masonry.

Contract price : —

Brick-work, American cement mortar, per cubic yard, . . .	\$12 00
Brick-work, Port'and cement mortar, per cubic yard, . . .	14 25
Concrete, American cement mortar, per cubic yard, . . .	5 50
Concrete, Portland cement mortar, per cubic yard, . . .	6 25
Approximate cost of masonry per linear foot, including under-drain, gravel refilling around sewer, etc. : —	
Larger sewer, ...	17 80
Smaller sewer, ...	7 00
Length completed, larger sewer, 2,293 feet; smaller sewer, 828 feet, ...	3,121 feet.

Masonry begun, Sept. 11, 1891, and is now in progress.

Approximate cost of section per linear foot of trench and masonry, including labor, material, inspection and miscellaneous items : —

Larger sewer, ...	\$33 10
Smaller sewer, ...	16 20

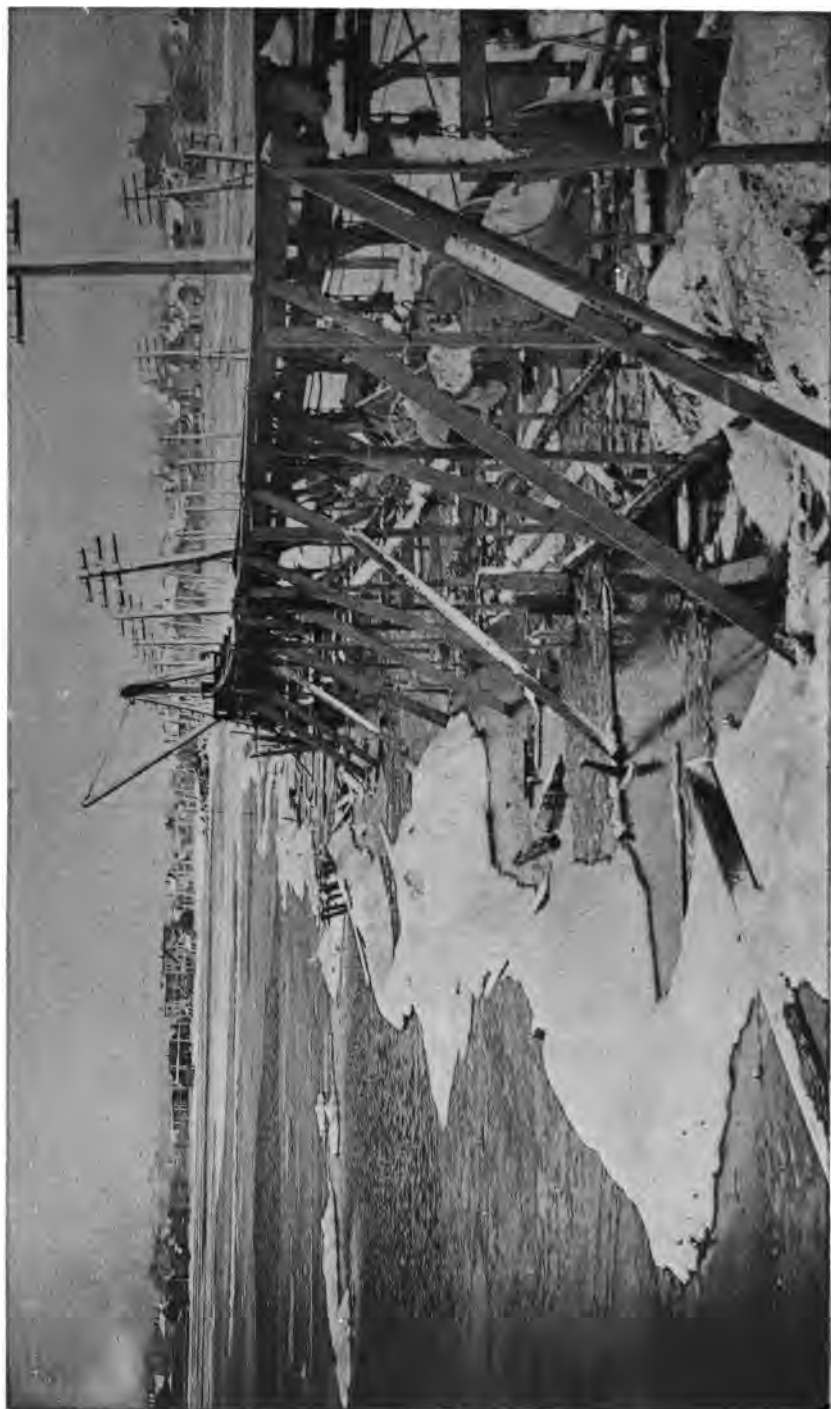
NOTE. — The information regarding Section 16 following this note relates solely to the year ending Sept. 30, 1892. For a description of the work performed prior to this year, see the third annual report.

Excavation. — A trench machine has been used for a distance of 1,850 feet from where the sewer leaves Second Street, along the south side of the Boston & Maine tracks. The work from the second opening, starting at Bow Street, was continued to the bell-mouth at the junction of Section 23, a distance of 750 feet. This excavation was done with a derrick. The bell-mouth was temporarily omitted. One hundred and fifty feet of the trench for the larger size sewer was dug by means of a derrick. The stream of spring water in Second Street, to which allusion was made last year, necessitated the continuous use of a six-inch pump for three months. Later this pump was moved to another well 550 feet ahead, and there run about one-third of the time. Five hundred feet above this a third well was placed, where pumping went on for about one-third of the time. Six-inch, ten-inch and twelve-inch underdrain has been used.

Foundation. — For the first 300 feet in Second Street, for about 1,400 feet on the marsh and the upper 800 feet of the section, the bottom of the trench was excavated to fit the invert of the sewer. At a point 1,800 feet from the beginning of the section the clay strata dipped down, and a layer of fine sand was encountered which was underlaid by coarse gravel furnishing water freely and causing a continual boiling of the sand, which demoralized the trench. Driven wells were resorted to, to control the water, but before a sufficient number had been driven to accomplish this the contractors moved ahead, omitting for a time a gap of 500 feet, only 200 feet of which contains, however, the fine sand in the bottom. For a distance of 50 feet in the beginning peat averaging 2 feet in depth below the masonry was excavated to firm clay, and a filling of American concrete used. At several other points along the line soft clay was thrown out and gravel substituted.

Difficulties. — The gap alluded to above will be the most difficult point on the section. The tide several times broke through the dikes, filled the trench, and seriously retarded the work.

Accidents. — On Aug. 6, 1892, an accident occurred by which James Malone, who was acting as foreman, lost his



Section 16, East Everett, during very high tide, January 12, 1892. Trench flooded.



life. While a bucket of clay was hoisting, the sheave was released by the breaking of a pin in the boom of the derrick, and, striking Mr. Malone in its descent, fractured his skull. He was carried to the Massachusetts General Hospital, where he died the same day.

Progress. — Two gangs have been employed. Under favorable conditions the ordinary progress per week on the 8 feet 2 inches by 8 feet 10 inches sewer has been 50 feet, and 35 feet on the smaller size. The sewer was built to a point 1,200 feet from the beginning of the section, when so many delays occurred from the high courses of tides that on February 29 the job was shut down, and remained so until May 5, 1892.

Miscellaneous. — An embankment about 3 feet in height above the surface of the earth has been or will be built over most of the sewer where it is in private land. The great amount of water pumped from the well near the railroad dried all of the shallow wells in this vicinity and some half a mile distant, resulting in inconvenience to householders and manufacturers.

SECTION 17, EVERETT.

Location. — From the junction of Broadway and Bow Street, through private lands, across the Eastern and Saugus Branch railroads, through Fleet, Cross and Williams streets, and along the Saugus Branch Railroad to Waters Avenue, thence curving to the left and through marsh lands for 220 feet toward the Malden River.

Length of section, ... 3,540 feet.

Diameters of sewers and length of each size: —

5 feet 10 inches by 6 feet 4 inches, . . . 3,304 "

4 feet 8 inches by 5 feet 1 inch, . . . 223 "

Contractor — Christy McBride of Brighton, Mass.

Contractor's Superintendents. — Devine Brothers.

State Assistants (Year ending Sept. 30, 1892).

Inspectors: George A. Chase, John D. Collins, Daniel J. Sullivan.

Transitmen: Principal — Paul W. Rowell.

" Assistants — Fred Brett, E. S. Foster, G. H. Chase, George R. Winslow.

Trench.

Length completed, ...	3,062.00 feet.
Average depth of excavation to bottom of underdrain, ...	21.40 "
Greatest depth of excavation to bottom of underdrain, ...	32.50 "
Average width top of trench, ...	9.30 "
Average width bottom of trench, ...	8.80 "
Cubic yards excavation per linear foot, 6.50.	
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below grade, etc., \$7.00.	

Character of Earth Excavation. — Peat, gravel, sand and clay in varying strata. The sewer rests upon clay mainly and also gravel.

Masonry.

Contract price: —

Brick-work, American cement mortar, per cubic yard, ...	\$13 60
Brick-work, Portland cement mortar, per cubic yard, ...	15 00
Concrete, American cement mortar, per cubic yard, ...	5 00
Concrete, Portland cement mortar, per cubic yard, ...	6 50
Approximate cost of masonry per linear foot, including under- drain, etc., ...	
	8 75
Length completed, ...	2,936 feet.

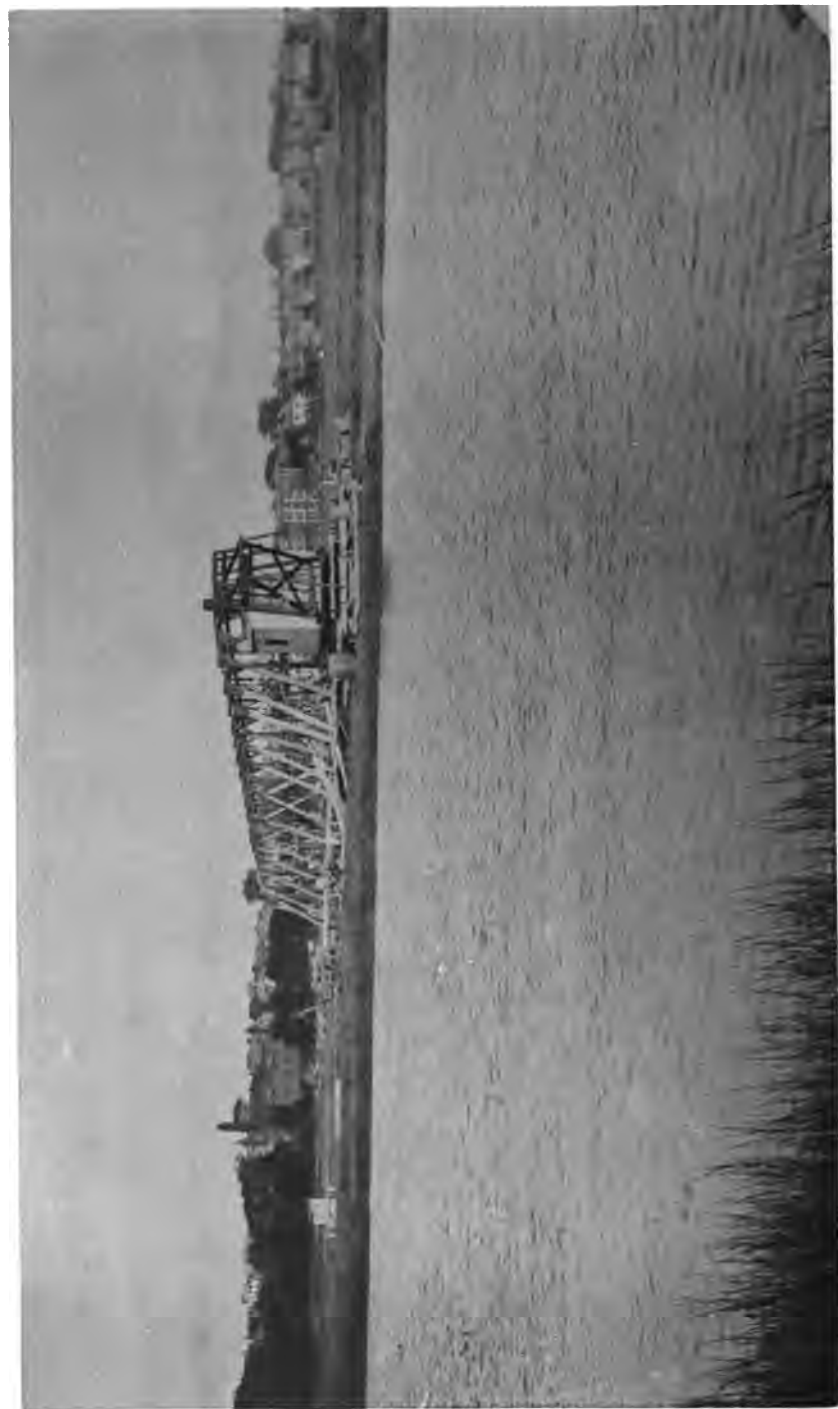
Masonry begun, Sept. 22, 1891, and is now in progress.

Approximate cost of section per linear foot of trench and masonry,
including labor, material, inspection and miscellaneous items, \$16 70

NOTE. — The information regarding Section 17 following this note relates solely to the year ending Sept. 30, 1892. For a description of the work performed prior to this year, see the third annual report.

Excavation. — The first 1,200 feet were excavated by means of a derrick, the remainder with a trench machine. Work began near Bow Street. Two large springs were encountered, one at the marsh near Broadway and one opposite Faxon's foundry, which necessitated the digging of pump wells in which six-inch pumps were run for three months. Other than this no great amount of water has been encountered. Eight and ten inch underdrain has been used. About 400 feet remains to be done westerly from Station 9 near the Saugus Branch Railroad.

Foundation. — The bottom of the trench has been excavated to fit the invert of the sewer as follows: for the first 690 feet and for 350 feet in Fleet Street, near Wellington Avenue, and from Norman Street to the end of the section. A concrete invert section, or a cradle section, has been used elsewhere.



Section 17 1-2, Everett. July 18, 1892. Malden River.

Difficulties. — At the points where the sewer crosses under the Eastern and Saugus Branch railroads the arch is reinforced with Portland concrete. The great depth of part of the trench is noted in the table.

Accidents. — An Italian dump-man fell from the trench machine to the ground, and was laid up for several weeks.

Progress. — For most of the time one gang has been employed. Occasionally work has progressed in two places at the same time. With a complete gang working, the ordinary progress per week has been 60 feet. There have been no shut-downs except for storms.

Miscellaneous. — A change was made in the sewer line at the request of the contractor and property owners, so that from Fleet Street to Williams Street the sewer, instead of curving into and out of Tileston Street, sweeps by a reversed curve from Fleet Street through private property into Williams Street. For the first 400 feet an embankment 1 foot in height above marsh level has been made over the sewer.

SECTION 17½, EVERETT.

Location. — From a point about 175 feet westerly from the West Street station, traversing the marsh in a westerly direction, to a point about 100 feet distant from the Malden River.

Length of section, ... 1,627 feet.

Diameter of sewer, 4 feet 8 inches by 5 feet 1 inch.

Contractors — Metropolitan Construction Company of Boston, Mass.

Contractors' Superintendent. — George W. Judd.

State Assistants.

Inspectors: John D. Collins, Patrick McCarthy, B. L. Sykes.

Transitmen: Principal — Paul W. Rowell.

“ Assistants — Fred. Brett, George E. Howe, G. H. Chase, George R. Winslow.

Trench.

Length completed, ... 1,627.00 feet.

Average depth of excavation to bottom of underdrain, . 17.00 “

Greatest depth of excavation to bottom of underdrain, . 17.50 “

Average width top of trench, ... 8.50 “

Average width bottom of trench, ... 7.00 “

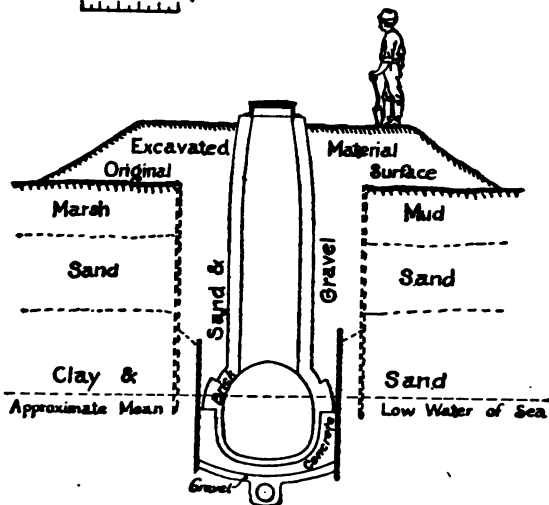
Cubic yards excavation per linear foot, 4.40.

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below grade, etc., \$5.25.

Cross-section at Manhole
Section 17½, Sta. 43.
Everett.

Scale
0 1 2 3 4 5 ft

Looking Northwest



Sand

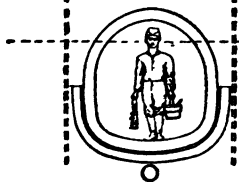
Gravel

Cross-section at Station 18+65.
Section 17.
Fleet Street, Everett.

Looking North

Scale
0 1 2 3 4 5 ft

Approximate Mean Low Water of Sea.



Character of Earth Excavation. — The upper three feet through turf and peat, and the underlying material of varying strata of clay, wet sand and silt in irregular mixings, to fairly firm sand or clay in the bottom.

Masonry.

Contract price : —

Brick-work, American cement mortar, per cubic yard, . . .	\$13 60
Brick-work, Portland cement mortar, per cubic yard, . . .	15 00
Concrete, American cement mortar, per cubic yard, . . .	5 00
Concrete, Portland cement mortar, per cubic yard.	6 50
Approximate cost of masonry per linear foot, including under-	
drain, etc., ...	7 90
Length completed, ...	1,627 feet.

Masonry begun, Jan. 7, 1892; finished, Aug. 10, 1892.

Approximate cost of section per linear foot of trench and masonry,
including labor, material, inspection and miscellaneous items, \$14 70

Excavation. — A trench machine was used on the whole of the section. The start was made Dec. 9, 1891, at the lower end of the section. A six-inch pump, operated in a pump well near the beginning of the section, together with ten-inch underdrain, kept the trench free from ground-water for its whole length.

Foundation. — For a length of 260 feet at the beginning of the section the bottom of the trench was excavated to fit the invert of the sewer. At a small creek 300 feet from the beginning a length of 40 feet was excavated $2\frac{1}{2}$ feet below sewer grade to sandy clay, and refilled. In the last 100 feet an average depth of 5 feet of silt was removed and a gravel foundation made, except for the last 8 feet, where the filling was of concrete.

Difficulties. — The high courses of tides caused much trouble, and the water occasionally found its way through the marsh drainage ditches, undermining the trench and causing the timbering to fall in, and necessitating much extra labor.

Progress. — The ordinary progress per week of the gang employed was, under favorable conditions, 120 feet. The work from Feb. 12 to April 8, 1892, was discontinued on account of very high tides and unfavorable weather. On April 25 the tide broke into the trench, and the work was shut down until the 5th of May, when the tides were lower.

Miscellaneous. — The filling over the arch was everywhere at least 9 feet in thickness. For a length of 1,225 feet an

embankment was built over the sewer to a height of 3 feet above the marsh level. At the creek near the middle of the marsh a culvert of rubble masonry was built upon the concrete arch of the sewer. The brick section of the sewer was here of four-inch work, and was surrounded by Portland concrete 2 feet in thickness over the arch.

SECTION 20, MEDFORD.

Location.— From a point on the marsh about 600 feet east of the Wellington station through marsh, crossing the Boston & Maine Railroad (Western Division, main line) to Third Street, through this street, private land, Ship Street and Riverside Avenue to Park Street. In this section is also included the Edgeworth branch, which extends through Craddock Avenue and the projected location of Pearl Street to a point in Malden about 60 feet north of the Medford line.

Length of section, main line, 7,640 feet; Edgeworth branch, 1,580 feet, ... 9,170 feet.

Diameters of sewers, and length of each size:—

4 feet 8 inches by 5 feet 1 inch (main line), . . . 1,480 "
4 feet 5 inches by 4 feet 8 inches (main line), . . . 6,210 "
2 feet (Edgeworth branch), ... 1,580 "

Contractor.— John Sheehan of Lynn, Mass. Mr. Sheehan has acted as his own superintendent.

State Assistants.

Assistant Engineer and Inspector: John S. Hodgson.

Trench.

Length completed, main line, ... 5,622.00 feet.
Length completed, Edgeworth branch, ... 508.00 "
Average depth of excavation to bottom of underdrain,
main line, ... 18.00 "
Average depth of excavation to bottom of underdrain,
Edgeworth branch, ... 15.00 "
Greatest depth of excavation to bottom of underdrain,
main line, ... 24.00 "
Greatest depth of excavation to bottom of underdrain,
Edgeworth branch, ... 17.00 "
Average width top of trench, main line, ... 8.00 "
Average width top of trench, Edgeworth branch, ... 6.50 "
Average width bottom of trench, main line, ... 7.00 "
Average width bottom of trench, Edgeworth branch, ... 6.00 "
Cubic yards excavation per linear foot, main line, 4.75.
Cubic yards excavation per linear foot, Edgeworth branch, 3.50.

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below grade, etc. (main line), \$3.90.

Character of Earth Excavation. — Chiefly clay; silt and peat on marsh, with sand over at upper end; sand on Edgeworth branch; hard-pan at present point of operations on main line (Spring Street).

Masonry.

Contract price: —

Brick-work, American cement mortar, per cubic yard, . . .	\$12 70
Brick-work, Portland cement mortar, per cubic yard, . . .	14 00
Concrete, American cement mortar, per cubic yard, . . .	5 00
Concrete, Portland cement mortar, per cubic yard, . . .	6 50
Approximate cost of masonry per linear foot, including under-	
drain, etc. (main line), ...	6 60
Length completed, main line, 5,543 feet; Edgeworth branch,	
487 feet, ...	6,030 feet.

Masonry begun, Oct. 28, 1891, and is now in progress on main line.

Approximate cost of section per linear foot of trench and masonry, including labor, material, inspection and miscellaneous items (main line), ... \$11 20

Excavation. — Operations began on the marsh, about 200 feet west of Malden River. A steam derrick was used between Malden River and the Boston & Maine Railroad and a trench machine on the remainder of the main line. Staging was used on the Edgeworth branch and under the railroad. Work on the main line has reached Spring Street; that on the Edgeworth branch stopped near First Street. There was a considerable volume of water in the trench on the marsh, and still more on the Edgeworth branch. There has been much less from the Boston & Maine Railroad to the present location of the work at Spring Street. A six-inch centrifugal pump was used throughout on the main line. A four-inch centrifugal pump was used on the Edgeworth branch, but this was materially assisted by the larger pump being at that time within 350 feet. The underdrain used has been six-inch, eight-inch and ten-inch, not more than one line of pipe being used in each trench.

Foundation. — Generally speaking, the trench of the whole of the main line has been excavated to fit the invert of the sewer, except on the marsh, where a length of 350 feet has been formed with concrete invert faced with brick-work. Timber cradle has been used on nearly the whole of the Edgeworth branch. No quicksand, properly so called, has been encountered, but the bottom on the marsh was of a very

shifty character until the water was removed by the underdrain and the pumps. After that was done the sand was perfectly firm. On the marsh a layer of broken stone was used as a bed on which to place the concrete invert. No piling has been used, except under the Boston & Maine Railroad, where 14 twenty-foot oak piles, one foot in diameter, capped and bolted, were used as a bearing for the double main line track. The railroad traffic was uninterrupted while the sewer was under construction.

Difficulties. — The chief difficulty was encountered in the commencement, on the marsh, the trench being in silt and peat, with fine sand and water at bottom. Added to this, the tide broke in on several occasions, doing damage to the plant and delaying the work. There have been three occasions on which the underdrain has become permanently blocked, in situations where the contractor did not wish to put down a new well, and much trouble has been caused by this. Where the exact contour of the sewer has not been obtainable in the trench, extra brick-work or gravel filling, according to circumstances, has been used to make the back of the invert solid. The sewer arch has been reinforced by concrete under the railroad tracks. At pump wells the sewer invert has been backed with concrete and the haunches filled with same material.

Progress. — Generally one gang has been employed (on the main line). Two gangs were employed during the work on the Edgeworth branch. The ordinary progress per week at each opening, with a complete gang working, has been 130 feet. The work on the main line has been carried on continuously, but operations on the Edgeworth branch (commenced Nov. 30, 1891) were carried on irregularly to May 28, 1892, and nothing has been done since, nor will be until the completion of the main line.

Miscellaneous. — There have been none but minor deviations in the detailed setting out of the work. A timber culvert, used by the Bay State Brick Company, was carried over the sewer arch on a solid concrete wall, commencing at the springing of the arch. The surplus earth from the sewer trench has been used for filling up low land near the sewer, thus benefiting greatly the Wellington estate.



HELIOTYPE PRINTING CO., BOSTON.

Section 21, High Street, Medford. May 14, 1892.

SECTION 21; MEDFORD.

Location. — From a point in Riverside Avenue at Park Street, through Riverside Avenue, across Gravelly Brook, Boston & Maine Railroad and branches, through High Street to the high school building, thence across private land, a creek west of the Mystic River, to Prescott Street, thence through Prescott Street to near the easterly line of Canal Street in West Medford.

Length of section, ... 8,265 feet.

Diameters of sewers and length of each size: —

4 feet 5 inches by 4 feet 8 inches, ... 2,596 "

4 feet 3 inches by 4 feet 6 inches, ... 5,669 "

Contractors. — National Construction Company of Boston, Mass. Thomas J. Young was general manager. A. E. Weaving was their general foreman.

State Assistants.

Assistant Engineer: Edmund S. Davis.

Inspectors: Henry M. Woodward, H. B. Damon, Warren A. Rogers, Frank M. Sherman.

Transitmen: Principal — Guy C. Emerson.

" Assistant — Burton A. Clark.

Trench.

Length completed, ... 8,035.00 feet.

Average depth of excavation to bottom of underdrain, ... 14.00 "

Greatest depth of excavation to bottom of underdrain, ... 24.00 "

Average width top of trench, ... 8.50 "

Average width bottom of trench, ... 7.50 "

Cubic yards excavation per linear foot, 4.10.

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below grade, etc., \$3.75.

Character of Excavation. — Mostly sand and gravel; peat on the marsh and some peat just west of Gravelly Brook; clay in the bottom of a portion in Riverside Avenue, and in High Street, near Medford Square, also in Prescott Street; some ledge in High Street, in front of the school-house, and along about 150 feet of the line beginning about 1,100 feet west of Winthrop Street.

Masonry.

Contract price: —

Brick-work, American cement mortar, per cubic yard, . . . \$12 45

Brick-work, Portland cement mortar, per cubic yard, . . . 14 15

Concrete, American cement mortar, per cubic yard, . . . 5 35

Concrete, Portland cement mortar, per cubic yard, . . . 6 95

Approximate cost of masonry per linear foot, including platform,
 underdrain, etc., ... \$6 80
 Length completed, ... 8,030 feet.

Masonry begun, Nov. 23, 1891; finished, Aug. 12, 1892.

Approximate cost of section per linear foot of trench and masonry,
 including labor, material, inspection and miscellaneous items, \$11 80

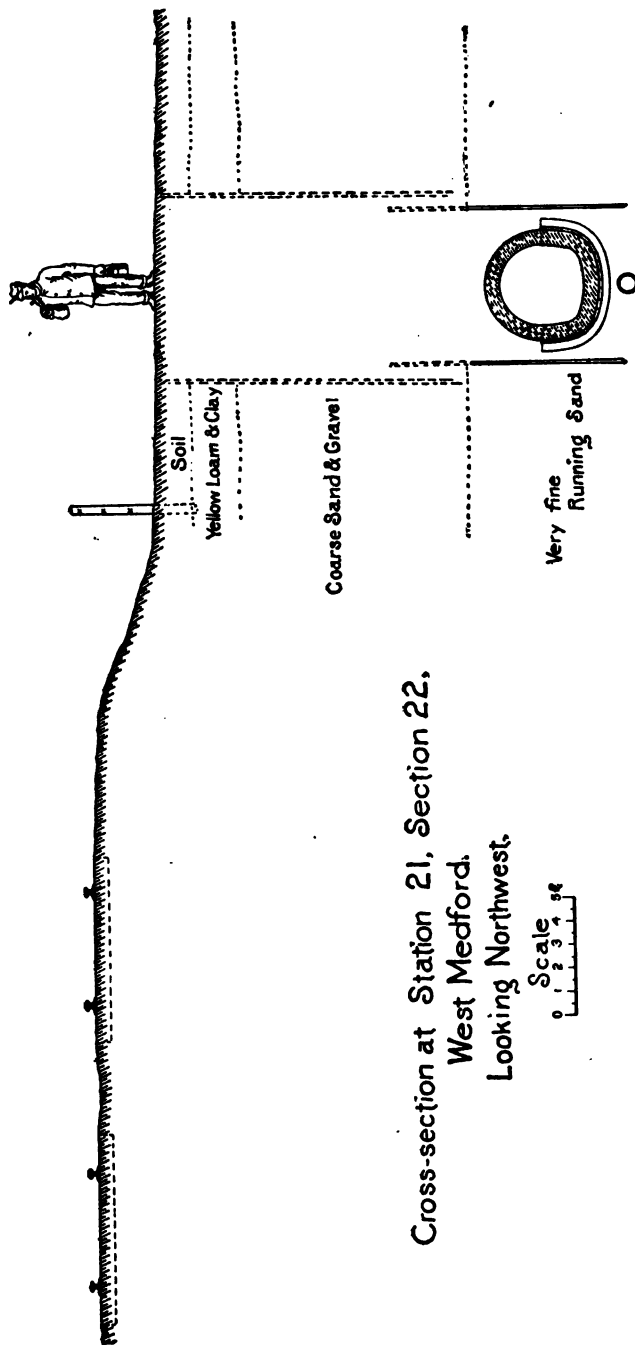
Excavation. — A trench machine was used in Riverside Avenue, Prescott and High streets. Work was begun Nov. 16, 1891, at a point about 300 feet west of Winthrop Street. A six-inch centrifugal pump, together with six-inch, eight-inch and ten-inch underdrain, kept the trench clear of ground-water.

Foundation. — A large portion of the bottom of the trench admitted of its being excavated to fit the invert of the sewer. Between Gravelly Brook and the Medford Branch Railroad, and on the marsh both sides of Winthrop Street, as well as on the marsh about 750 feet east of Prescott Street, excavation was made below sewer grade and refilled with concrete.

Difficulties. — The sewer passes under the Medford Railroad and branch in Riverside Avenue, and also under a small brook near the westerly end of Prescott Street in West Medford. At these points the sewer section was reinforced with concrete from the bottom up to the crown of the arch. At the above-mentioned brook crossing, a flag stone was built in the top of the sewer and the cross-section of the sewer slightly changed, to avoid raising the bed of the stream. The considerable depth of trench in High Street is noted in the above table.

Accidents. — There were no serious accidents to men or buildings. A small portion of the trench caved in on High Street, in front of the high school building, caused by blasting in the bottom of the trench.

Progress. — Three gangs were employed most of the time. A portion of the time, when crossing the marsh, four were at work. The ordinary progress per week at each opening, with a complete gang working, was about 150 feet. Two openings on the marsh were shut down about a week each, on account of high tides which interfered with the work. The work on this section was completed more than six months in advance of the time named in the contract.



Cross-section at Station 21, Section 22.
West Medford.
Looking Northwest.

Miscellaneous. — At Gravelly Brook and at a brook crossing east of Winthrop Street gaps were left in the contract section, and the work at these points will be done directly by the State. The sewer line in Riverside Avenue was changed about 1 foot towards the centre of the avenue, to avoid injury to the shade trees, and a slight change was made through High Street, to avoid damage to a gas main. Most of the surplus earth from the sewer was used by the town of Medford for grading streets. The greater part of the sand and gravel used for masonry was obtained from the trench.

SECTION 22, WEST MEDFORD.

Location. — Through Canal Street, from its junction with Prescott Street, across High Street and through Warren Street, crossing a brook near Irving Street, thence crossing private lands, Irving Street and private lands again and along the easterly side of the Boston & Lowell Railroad, across Grove Street to a point on the easterly side of the railroad about 1,200 feet north of Grove Street, thence across the railroad and private land to near the Mystic dam.

Length of section, ... 6,080 feet.

Diameter of sewer, 3 feet 4 inches by 3 feet 6 inches.

Contractor. — Andrew W. Bryne of Somerville, Mass. Mr. Bryne has acted as his own superintendent.

State Assistants.

Assistant Engineer: Edmund S. Davis.

Inspectors: John D. Collins, Henry M. Woodward.

Transitmen: Principal — Guy C. Emerson.

“ Assistant — Burton A. Clark.

Trench.

Length completed, ... 2,165.00 feet.

Average depth of excavation to bottom of underdrain, . 18.00 “

Greatest depth of excavation to bottom of underdrain, . 22.00 “

Average width top of trench, ... 7.67 “

Average width bottom of trench, ... 6.33 “

Cubic yards excavation per linear foot, 4.80.

Approximate cost of trench per linear foot, including
sheeting left in, excavation and refilling below grade,
etc., \$7.10.

Character of Earth Excavation. — Sand and some gravel near the surface; very fine running sand in lower portion of the trench, excepting for a short portion in Canal Street, where some clay was found.

Masonry.

Contract price: —

Brick-work, American cement mortar, per cubic yard, . . .	\$13 50
Brick-work, Portland cement mortar, per cubic yard, . . .	15 50
Concrete, American cement mortar, per cubic yard, . . .	5 00
Concrete, Portland cement mortar, per cubic yard, . . .	7 00

Approximate cost of masonry per linear foot, including under-

drain, etc., ... 5 70

Length completed, ... 2,120 feet.

Masonry begun, March 24, 1892, and is now in progress.

Approximate cost of section per linear foot of trench and masonry,

including labor, material, inspection and miscellaneous

items, ... \$14 60

Excavation. — A trench machine has been used. Trench work was begun Feb. 23, 1892, near the intersection of Canal and Prescott streets, and has now reached a point on the easterly side of the railroad, about 800 feet northerly from the West Medford station. The trench has been kept clear of ground-water by the use of a No. 5 pulsometer, and a three-inch Knowles pump, together with six-inch and eight-inch underdrain, in different portions of the trench as needed.

Foundation. — For a distance of 128 feet in Canal Street, in front of the stone yard, the foundation has been excavated to fit the invert of the sewer. A very fine running sand is found where work is being done at present along the easterly side of the railroad. For most of the distance between High Street and the present working near the railroad track coarse sand and gravel have been filled back of the cradling and on the sides of the sewer up to near the crown of the arch.

Progress. — One gang has been employed, and its ordinary progress per week under favorable conditions has been about 100 feet. There have been no shut-downs excepting for a day or two in unfavorable weather.

Miscellaneous. — The surplus earth has been used by adjacent property owners. Pipe wells are now being driven near the line of the sewer east of the railroad track and ahead of the excavating machine, for the purpose referred to in the description of the quicksand excavation on Section 12.

SECTION 23, EVERETT.

Location.— From a point on the marsh about 1,150 feet north-easterly from Beacham Street, southerly through marsh lands, and Ashland, Beacham and Bow streets to Lynde Street.

Length of section, ... 2,308 feet.

Diameter of sewer, 6 feet by 6 feet 8 inches.

Contractors.— R. A. Malone & Sons of Philadelphia, Pa.

Contractors' Superintendent.— R. J. Malone (to September 15).

Contractors' Superintendent.— Michael Tallent (since September 15).

State Assistants.

Inspectors: Samuel Corning, H. B. Damon.

Transitmen: Principal— Paul W. Rowell.

“ Assistants— Fred Brett, George E. Howe, G. H. Chase, George R. Winslow.

Trench.

Length completed, ... 1,860.00 feet.

Average depth of excavation to bottom of underdrain, . . . 24.50 “

Greatest depth of excavation to bottom of underdrain, . . . 34.50 “

Average width top of trench, ... 10.30 “

Average width bottom of trench, ... 9.30 “

Cubic yards excavation per linear foot, 8.20.

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below grade, etc., \$8.60.

Character of Excavation.— Mainly firm clay from the beginning of the section to Beacham Street; sand and gravel in Beacham Street; in Bow Street, sand, and for 150 feet rock averaging 5 feet in depth in the bottom.

Masonry.

Contract price:—

Brick-work, American cement mortar, per cubic yard, . . . \$12 00

Brick-work, Portland cement mortar, per cubic yard, . . . 13 75

Concrete, American cement mortar, per cubic yard, . . . 5 75

Concrete, Portland cement mortar, per cubic yard, . . . 7 00

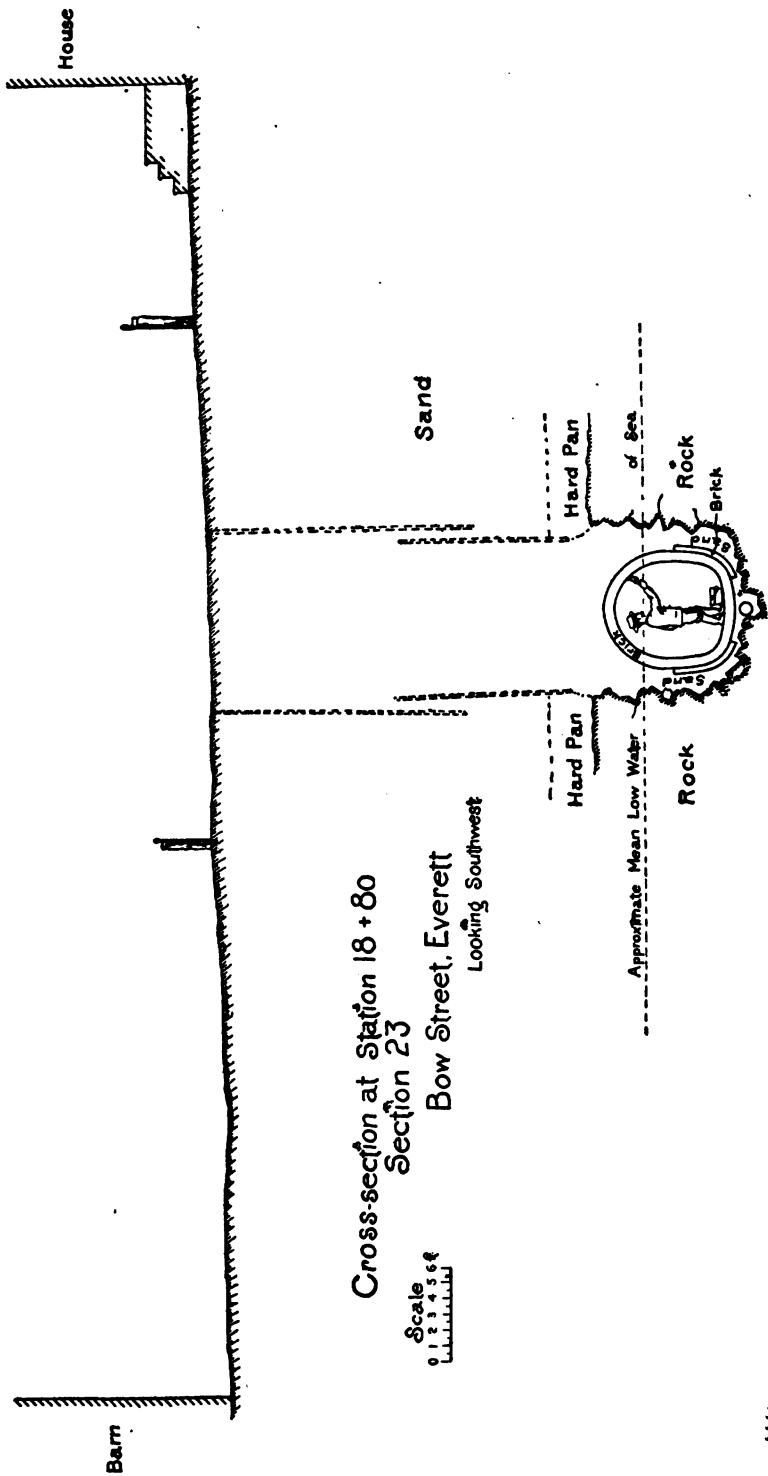
Approximate cost of masonry per linear foot, including underdrain, etc., ... 8 50

Length completed, ... 1,815 feet.

Masonry begun, Oct. 16, 1891, and is now in progress.

Approximate cost of section per linear foot of trench and masonry, including labor, material, inspection and miscellaneous items, ... \$18 60

Excavation.— Derricks have been employed. On Beacham Street two were used, one immediately ahead of the other. Operations were commenced Sept. 24, 1891, at the beginning of the section, and have now reached a point on Bow Street about 160 feet southerly from Courtland Street.



From the beginning to Beacham Street a hand pump was used, and since passing beyond this a four-inch pulsometer has been employed continually. Eight-inch underdrain has been used.

Foundation. — The bottom of the trench has been excavated to fit the invert of the sewer from the beginning to within 250 feet of Bow Street, a length of 1,316 feet.

Difficulties. — The principal drawbacks upon this division have been the occasional flooding of the entire trench on the marsh during high courses of tides ; the great depth of trench ; and the ledge.

Progress. — One gang has been at work, and this has part of the time been divided into two working parties. The ordinary progress per week, with a complete gang working, has been 40 feet.

Miscellaneous. — The least depth of filling over the crown of the arch occurs for the first 1,000 feet or so at the beginning of the section, and there it is about 12 feet.

SECTION 24, EVERETT AND CHARLESTOWN.

Location. — From a point in Bow Street, Everett, at the corner of Lynde Street, southerly through Bow Street, Broadway and Alford Street, Charlestown, to a point on Malden Bridge causeway in the Mystic River.

Length of section, ... 2,332 feet.

Diameter of sewer, 6 feet by 6 feet 8 inches.

Contractors. — Metropolitan Construction Company of Boston, Mass.

Contractors' Superintendent. — George W. Judd.

State Assistants.

Assistant Engineer : Wilbur F. Goodrich.

Inspector : Frank M. Sherman.

Trench.

Length completed, ... 2,332.00 feet.

Average depth of excavation to bottom of underdrain, . 25.00 "

Greatest depth of excavation to bottom of underdrain, . 30.00 "

Average width top of trench, ... 11.00 "

Average width bottom of trench, ... 9.80 "

Cubic yards excavation per linear foot, 9.60.

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below grade, etc., \$9.40.

Character of Earth Excavation. — Sand, clay, peat and stone filling.

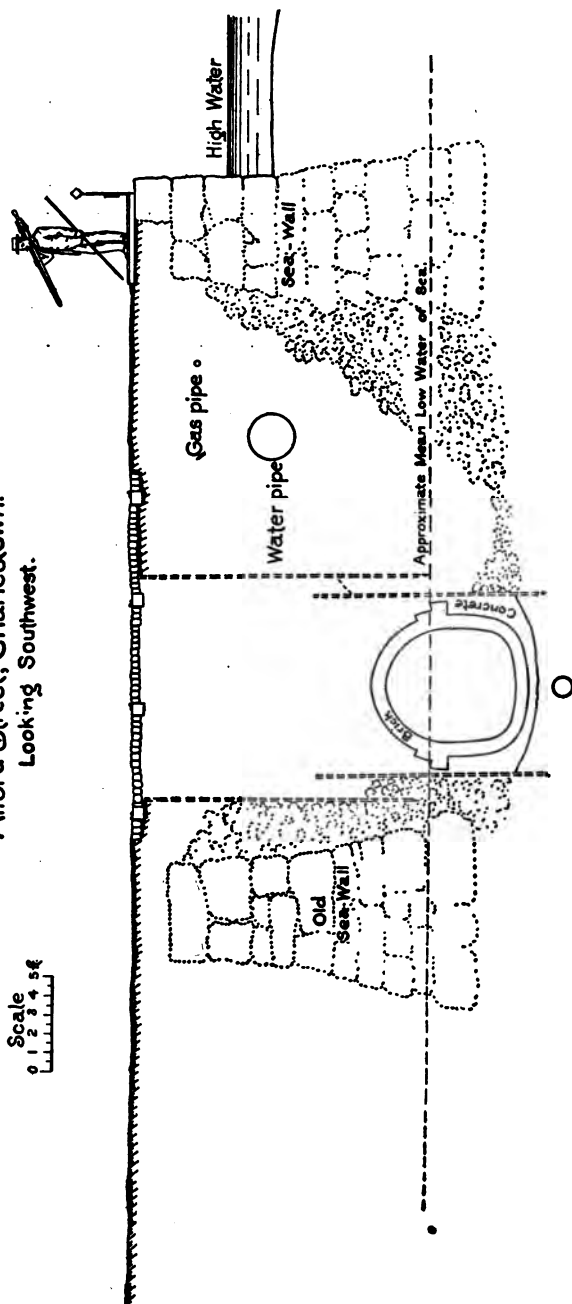
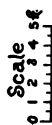


Section 24, Charlestown. Causeway at Mystic River, near Malden Bridge. April 15, 1892



Cross-section near Sta. 18+0,
Section 24.

Alford Street, Charlestown.
Looking Southwest.



Masonry.

Contract price :—

Brick-work, American cement mortar, per cubic yard, . . .	\$11 95
Brick-work, Portland cement mortar, per cubic yard, . . .	14 24
Concrete, American cement mortar, per cubic yard, . . .	4 95
Concrete, Portland cement mortar, per cubic yard, . . .	7 17
Approximate cost of masonry per linear foot, including under-	
drain, etc., ...	10 00
Length completed, ...	2,332 feet.

Masonry begun, Dec. 19, 1891 ; finished, May 28, 1892.

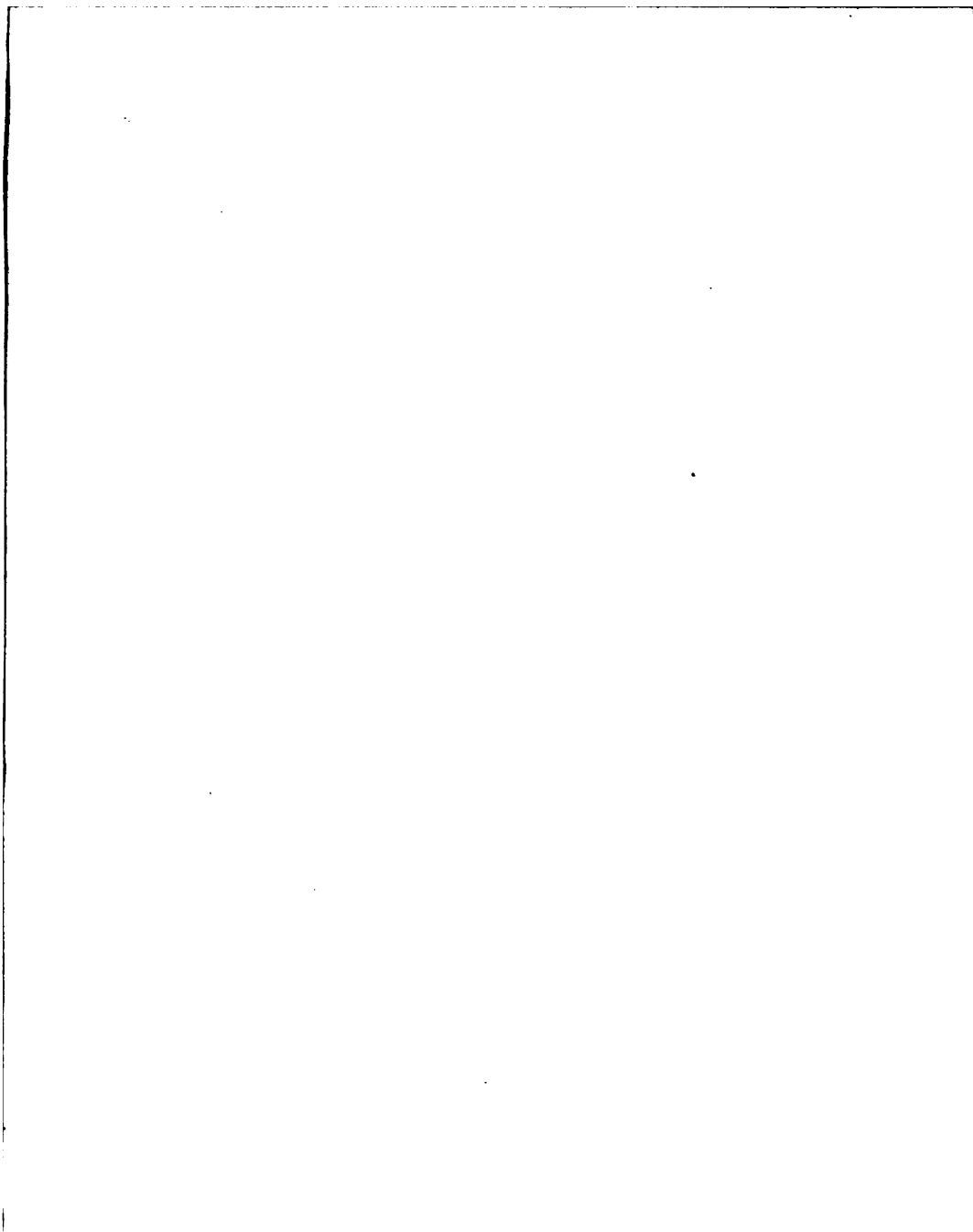
Approximate cost of section per linear foot of trench and	
masonry, including labor, material, inspection and miscel-	
laneous items, ...	\$20 40

Excavation.—Trench machines were used. Work progressing south began Dec. 4, 1891, on Alford Street, at a point about 350 feet south of the Everett line. On Jan. 14, 1892, operations progressing north were commenced at the original starting point of the first opening. Two eight-inch pumps, together with eight-inch, ten-inch and twelve-inch underdrain, were used in dealing with the water encountered.

Foundation.—Most of the foundation from the beginning of the section to Sackville Street admitted of its being excavated to fit the invert of the sewer. For short distances between Sackville Street and Malden bridge it was necessary to excavate below sewer grade and fill with firmer material.

Difficulties.—As the work progressed towards the south, an old wall (formerly the easterly wall of the causeway) was met at a point on Alford Street about 500 feet beyond the almshouse, and this continued to the southerly end of our work. This wall acted as a blind drain, through which flowed large quantities of salt water. To avoid this obstacle the sewer line was moved about 5 feet to the west, thus bringing it somewhat nearer the westerly causeway. While doing the intervening work between the point where the old wall was met and the draw, the tide came through the causeway wall of Malden bridge in volume too great to be pumped. Tide-work was therefore resorted to, and masonry could be laid only during from one to three hours on each tide.

Progress.—Two gangs were employed, and the ordinary progress per week of each, with the full force, was from 68 to 69 feet.





Section 26, under Sullivan Square, Charlestown. Tunnel drift. May 29, 1892.

Miscellaneous. — At Mystic Street the Metropolitan sewer passed under an old local brick sewer, 3 feet by 3 feet 2 inches in diameter, which was rebuilt. The space between the under side of the Everett sewer and the arch of the Metropolitan sewer was about 2 feet 9 inches, and this was filled with concrete. About 100 feet north of Sackville Street a box culvert 2 feet square was passed under, and was replaced. The space of 4 feet between the culvert and the Metropolitan sewer was filled with concrete. The surplus earth from the sewer has been used by adjacent property owners.

SECTION 26 (CONTRACT WORK), CHARLESTOWN AND SOMERVILLE.

Location. — From a point about 250 feet westerly from Arlington Avenue near the bulkhead in Tufts' Mill Pond, through Charlestown playground, across Main Street, through Cambridge Street to the tracks of the Boston & Maine Railroad, and under them to Roland Street, through Roland Street and the McLean Asylum grounds to the Mystic Branch Railroad.

Length of section, ... 3,750 feet.

Diameters of sewers, and length of each size: —

6 feet 6 inches by 7 feet 2 inches, ... 528 "

5 feet 9 inches by 6 feet 6 inches, ... 3,222 "

Contractor. — H. P. Nawn of Roxbury, Mass.

Contractor's Superintendent. — James D. Fallon.

State Assistants.

Assistant Engineer: Frank I. Capen.

Inspectors: E. A. Clark, George F. Greenlaw, Samuel P. McKenzie, James E. Coyne, Frank M. Sherman.

Transitmen: Principals — C. Barton Pratt, Wm. W. Lewis.

" Assistants — R. LeFrancis, E. S. Stevens, J. P. Whittren, J. H. Brennan

Trench and Tunnel.

Length completed of trench excavation, ... 622.00 feet.

Length completed of tunnel excavation, ... 971.00 "

Average depth of trench excavation to bottom of underdrain, ... 23.20 "

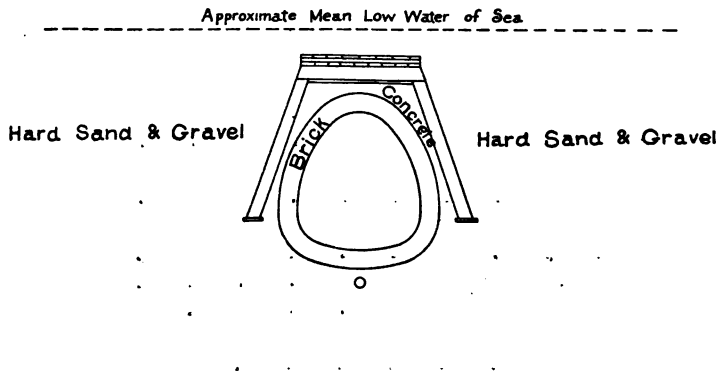
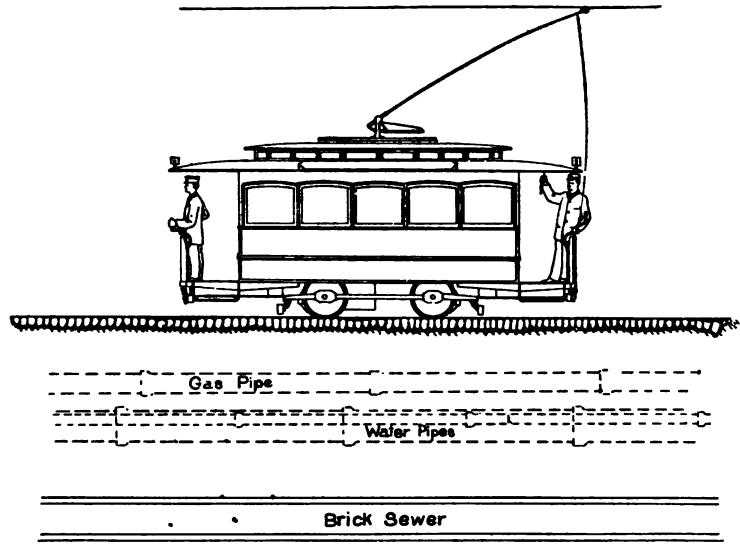
Greatest depth of trench excavation to bottom of underdrain, ... 27.00 "

Average width top of trench, ... 9.50 "

Average width bottom of trench, ... 8.00 "

Average depth from surface of ground to bottom of tunnel underdrain, ... 32.00 "

Cross-section near Station 4+0.
Section 26.
Main Street, Charlestown.
Scale 0 1 2 3 4 5 ft Looking Southwest



Greatest depth from surface of ground to bottom of tunnel underdrain, ...	32.50 feet.
Average width of tunnel, ...	8.50 "
Cubic yards trench excavation per linear foot, 7.70.	
Cubic yards tunnel excavation per linear foot, 3.10.	
Approximate cost of trench or tunnel per linear foot, including sheeting left in, excavation and refilling below grade, etc., \$11.40.	

Character of Earth Excavation.—Clay for 150 feet from the beginning of section, hard gravel for next 1,000 feet to near the railroad crossing; from a point opposite the Crosby Steam Gage Works, for about 700 feet on Roland Street to near the Charlestown and Somerville line, clay, with sand above.

Masonry.

Contract price:—

Brick-work, American cement mortar, per cubic yard, . . .	\$12 25
Brick-work, Portland cement mortar, per cubic yard, . . .	14 00
Concrete, American cement mortar, per cubic yard, . . .	5 00
Concrete, Portland cement mortar, per cubic yard, . . .	6 00
Approximate cost of masonry per linear foot, including underdrain, etc., ...	9 50
Length completed, trench, 623 feet; tunnel, 993 feet, . . .	1,616 feet.

Masonry begun, May 4, 1892, and is now in progress.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, ...	\$22 30
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Excavation.—Tunnel shafts were commenced as follows: in the Charlestown playground on April 18, 1892; in Sullivan Square on April 25; and near Spice Street on June 7. The headings between the second and third shafts met on August 13, and between the first and second on August 19. Between the second and third shafts the tunnel was around a curve of 300 feet radius for a distance of about 200 feet. The centre lines, nevertheless, agreed closely. Trench work was commenced opposite the Crosby Steam Gage Works on June 28. A derrick has been used at each of the three shafts, and a trench machine on the open trench. All that remains to be done north of the tracks of the Eastern and Boston & Maine railroads are several short gaps aggregating about 400 feet in length. The work done south of the railroad comprises a stretch of a little over 600 feet, from a point opposite the Crosby

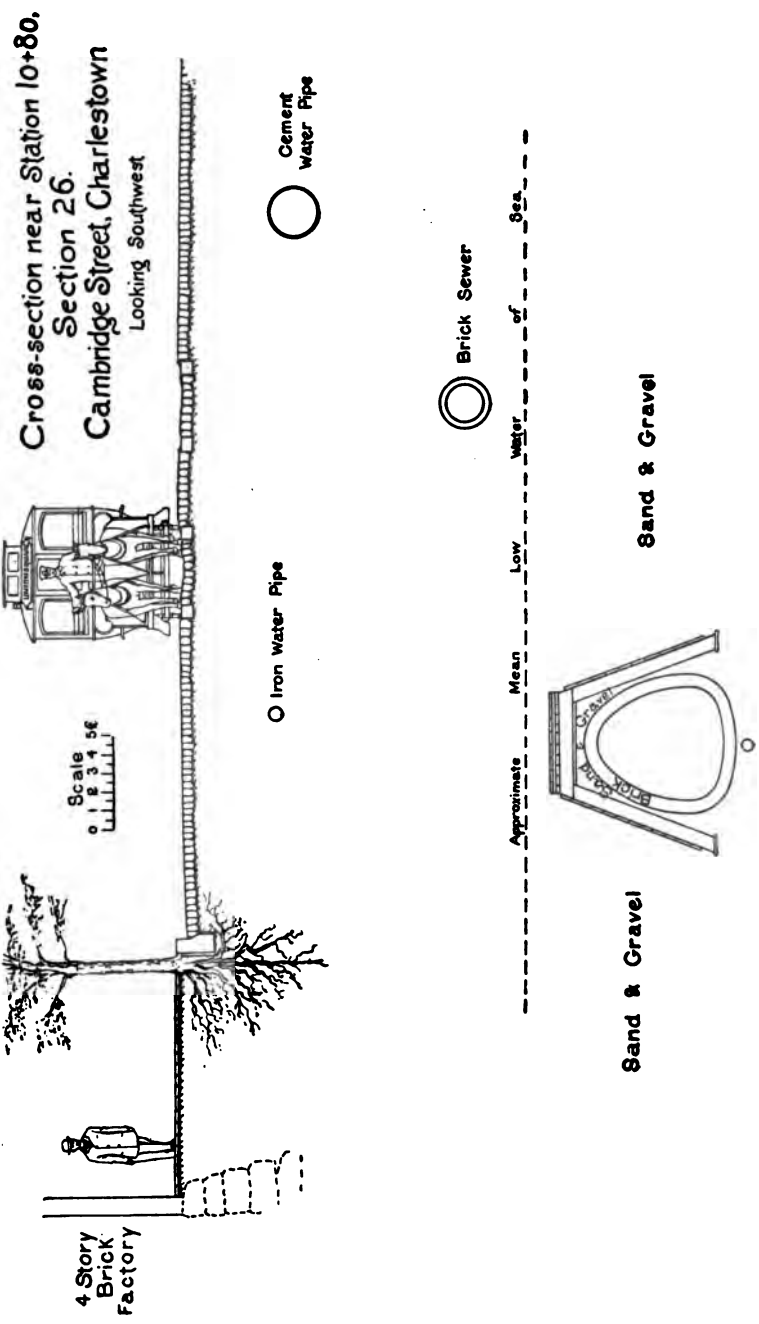
Steam Gage Works to near the Charlestown and Somerville line. The tunnel on Cambridge Street has been kept clear of ground-water by a two-inch ejector in each shaft, together with six-inch underdrain. At the open cut on Roland Street a five-inch Knowles pump has been used, together with eight-inch underdrain.

Foundation. — For all the way where the sewer has been built the bottom of the excavation has been shaped to fit the invert of the sewer, except for about 120 feet of the tunnel near the beginning of the section, opposite Van Nostrand's brewery. On May 28 this length of the tunnel slipped and had to be redriven. The slipping was probably due to the clay being saturated with water. Digging away for the invert of the sewer caused the legs of the timber sets to settle.

Tunnel Methods. — The supports in all the tunnel headings have been of wood. The timbering has been by sets of caps and legs placed about $4\frac{1}{2}$ feet apart. The caps are about 6 feet long and 8 inches by 8 inches. The legs are 5 to 8 feet long and 8 inches by 8 inches. Over these caps two-inch lagging has been driven, reaching from cap to cap. Usually not much lagging has been required on the sides, although in soft ground it has been required and used. In places where the ground was soft, and there was an extra weight on the caps, causing them to bend, the crown of the arch was reinforced by solid brick piers.

Progress. — In the tunnel five headings have been worked the larger part of the time. The ordinary tunnel progress per week, with complete gangs working, has been 50 feet. In open cut, with a complete gang working, the ordinary progress per week has been 60 feet. The work has been carried on without interruption.

Miscellaneous. — The surplus earth from the sewer, as far as the railroad crossing on Cambridge Street, has been deposited for filling in Tufts' Mill Pond.



PART OF SECTIONS 26 AND 27 (DAY WORK), SOMERVILLE.

Location.—From the easterly side of, and across, the Mystic Branch Railroad, through the McLean Asylum grounds, under the Boston & Lowell Railroad and private land to the corner of Joy and Poplar streets.

Length of section, ... 950 feet.

Diameter of sewer, 5 feet 9 inches by 6 feet 6 inches.

Assistants.

Assistant Engineer: Frank I. Capen.

Foreman: Patrick McCarthy.

Transitmen: Principals—C. Barton Pratt, Wm. W. Lewis.

“ Assistants—J. P. Whittren, J. H. Brennan.

Tunnel.

Length completed, ... 559.00 feet.

Average depth from surface of ground to bottom of under-drain, ... 35.00 “

Greatest depth from surface of ground to bottom of under-drain, ... 38.50 “

Average width of tunnel, ... 7.50 “

Cubic yards excavation per linear foot, 2.00.

Character of Excavation.—Slate and indurated clay. For about 225 feet, under and on each side of the Boston & Lowell Railroad, the rock was hard enough to stand without much timber; the rest of the way timber was constantly required.

Masonry.

Length completed, ... 445 feet.

Masonry begun, April 8, 1892, and is now in progress.

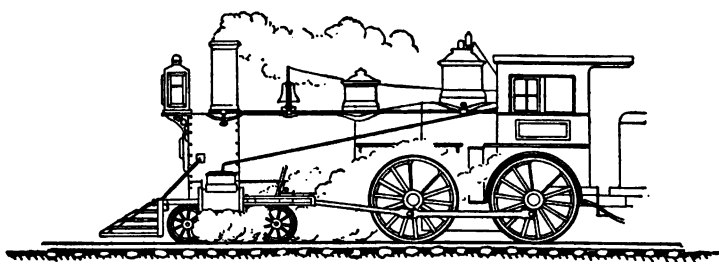
Approximate cost of this work per linear foot, tunnel and masonry, including labor, material and inspection, . . . \$25 10

Excavation.—Tunnel shafts were commenced as follows: east of the Boston & Lowell Railroad on February 26, west of the Boston & Lowell Railroad on March 28, and west of Asylum Avenue on May 23. An incline has been used at each of the shafts. Work has extended from a point about 100 feet east of Asylum Avenue to the corner of Joy and Poplar streets. The tunnel has been kept clear of ground-water by the use of a two-inch piston pump, together with a four-inch underdrain.

Cross-section near Station 3,
Section 27
B.&L.R.R., Somerville.

Scale
0 1 2 3 4 5 ft

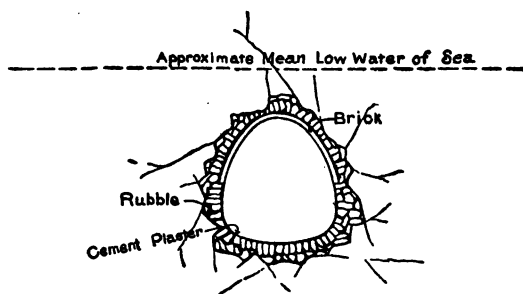
Looking Southwest



Sand & Gravel

Clay & Sand

Ledge



Foundation.—An even bearing for the invert has been secured by covering the bottom of the excavation with mortar, broken stone and gravel.

Progress.—One gang has been employed. Under favorable conditions the ordinary progress per week has been 35 feet, the work being carried on from two headings.

Miscellaneous.—The rock taken from the tunnel has been used to fill in low land in the McLean Asylum grounds.

SECTION 27 (CONTRACT WORK), SOMERVILLE AND CAMBRIDGE.

Location.—From the corner of Joy and Poplar streets, through Poplar Street to and across Somerville Avenue, land of North Packing and Provision Company, to and through Medford Street, and to and across the Fitchburg Railroad tracks, thence by the way of Warren, Cambridge and Portland streets to near Binney Street.

Length of section, ... 4,303 feet.

Diameters of sewers, and length of each size:—

5 feet 9 inches by 6 feet 6 inches, ... 770 "

5 feet 2 inches by 5 feet 9 inches, ... 3,533 "

Contractors.—McGovern & Kitch of Lancaster, Pa.

Contractors' Superintendent.—Davis Kitch (a member of the above-mentioned firm).

Contractors' Foremen.—James Carter, William Dwyer.

State Assistants.

Assistant Engineer: Frank I. Capen.

Inspector: George F. Greenlaw.

Transitmen: Principals—Wm. W. Lewis, C. Barton Pratt.

" Assistants—J. P. Whittren, John H. Brennan, R. LeFrancis.

Trench.

Length completed, ... 740.00 feet.

Average depth of excavation to bottom of underdrain, ... 23.50 "

Greatest depth of excavation to bottom of underdrain, ... 26.00 "

Average width top of trench, ... 8.50 "

Average width bottom of trench, ... 8.40 "

Cubic yards excavation per linear foot, 6.97.

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below grade, etc., \$8.50.

Character of Earth Excavation.—Street filling at the surface, then loam or peat, sand with some water, and clay to grade.

Masonry.

Contract price:—

Brick-work, American cement mortar, per cubic yard, . . .	\$11 00
Brick-work, Portland cement mortar, per cubic yard, . . .	12 40
Concrete, American cement mortar, per cubic yard, . . .	4 65
Concrete, Portland cement mortar, per cubic yard, . . .	6 50
Approximate cost of masonry per linear foot, including under- drain, etc., ...	7 05
Length completed, ...	593 feet.

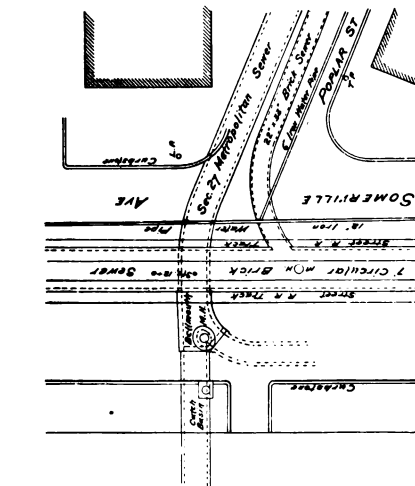
Masonry begun, June 29, 1892, and is now in progress.

Approximate cost of section per linear foot of trench and masonry, including labor, material, inspection and miscellaneous items, ... \$15 90

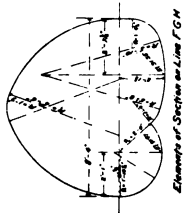
Excavation.—Work was started with three derricks at three openings on Poplar Street. During the latter part of July these were replaced by a trench machine. A trench machine has been used on Portland Street. Openings have been begun as follows: on June 6, corner of Joy and Poplar streets; June 23, corner of Linwood and Poplar streets; June 27, in yard of North Packing and Provision Company; and September 9, at the corner of Cambridge and Portland streets. At first, and for the larger part of the time, the trench in Poplar Street was kept clear of ground-water by using hand pumps and a two-inch ejector, together with six-inch underdrain. These pumping appliances have of late been replaced by a six-inch centrifugal pump. On Portland Street a four-inch centrifugal pump has been used, together with eight-inch underdrain.

Foundation.—For its total length so far, excepting about 60 feet through the ledge at the beginning of the section, the bottom of the trench has been excavated to fit the invert of the sewer. In some cases the clay has slipped, leaving pockets that have been filled with masonry.

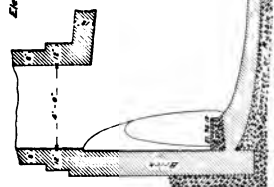
Difficulties.—On Poplar Street, where the excavation has been near and parallel to a local sewer, the contractor has not taken necessary precautions against allowing tide and storm water to back up. The internal pressure caused leaks in this local sewer, which soon burst and flooded the trench. In Linwood Street a concrete pier was built between the arch of the Metropolitan sewer and the invert of the local sewer, to prevent settlement due to a refilled trench.



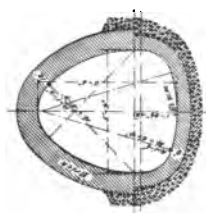
GENERAL PLAN
 Showing location of Ballmouth
 Scale 1" = 10'



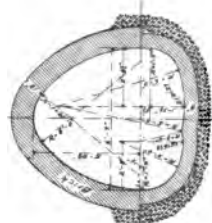
SCALE OF DETAILS
 1" = 8'



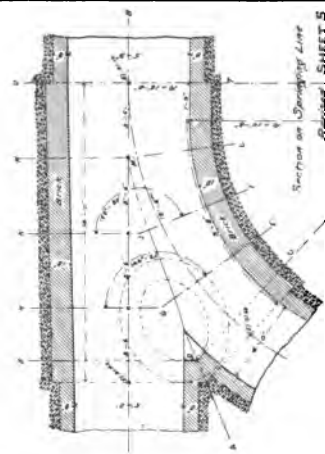
Section on Line A B B



Section on Line T U



Section on Line I J K



Section on Line C D E

Section on Springing Line
 Revised SHEET 5



SECTION 27
METROPOLITAN SEWER
 Details of Ball-Mouth near Station 12
 AUGUST 1892

J. J. M.

Accidents. — The rather precarious foundations of two buildings on Poplar Street, between Chestnut and Linwood streets, were somewhat settled. These foundations were rebuilt by the contractor. About 30 feet of the Poplar Street local sewer near Maple Street was burst and washed into the Metropolitan trench by storm and tide water.

Progress. — On Poplar Street the work was started by three gangs, but these were afterwards reduced to one. One gang worked on Portland Street, near Cambridge Street. On Poplar Street, when everything was favorable, the ordinary progress per week was 60 feet; and on Portland Street 48 feet. There have been no shut-downs that lasted long. The men at one time struck for twenty cents an hour in place of seventeen and one-half cents. This strike lasted for one day and was successful.

SECTION 40, EVERETT AND MALDEN.

Location. — From near Waters Avenue in Everett, along the westerly side of the Saugus Branch Railroad to Middlesex Street in Malden, and in this street to Charles Street.

Length of section, ... 6,250 feet.

Diameter of sewer, 3 feet 9 inches by 4 feet 1 inch.

Contractors. — R. A. Malone & Sons of Philadelphia, Pa.

Contractors' Superintendent. — R. J. Malone.

State Assistants.

Inspectors: Caleb Kimball, Frank M. Sherman.

Transitmen: Principal — Paul W. Rowell.

“ *Assistants* — Fred Brett, George E. Howe, E. S. Foster, G. H. Chase,
George R. Winslow.

Trench.

Length completed, ... 4,491.00 feet.

Average depth of excavation to bottom of underdrain, . . . 16.40 “

Greatest depth of excavation to bottom of underdrain, . . . 24.00 “

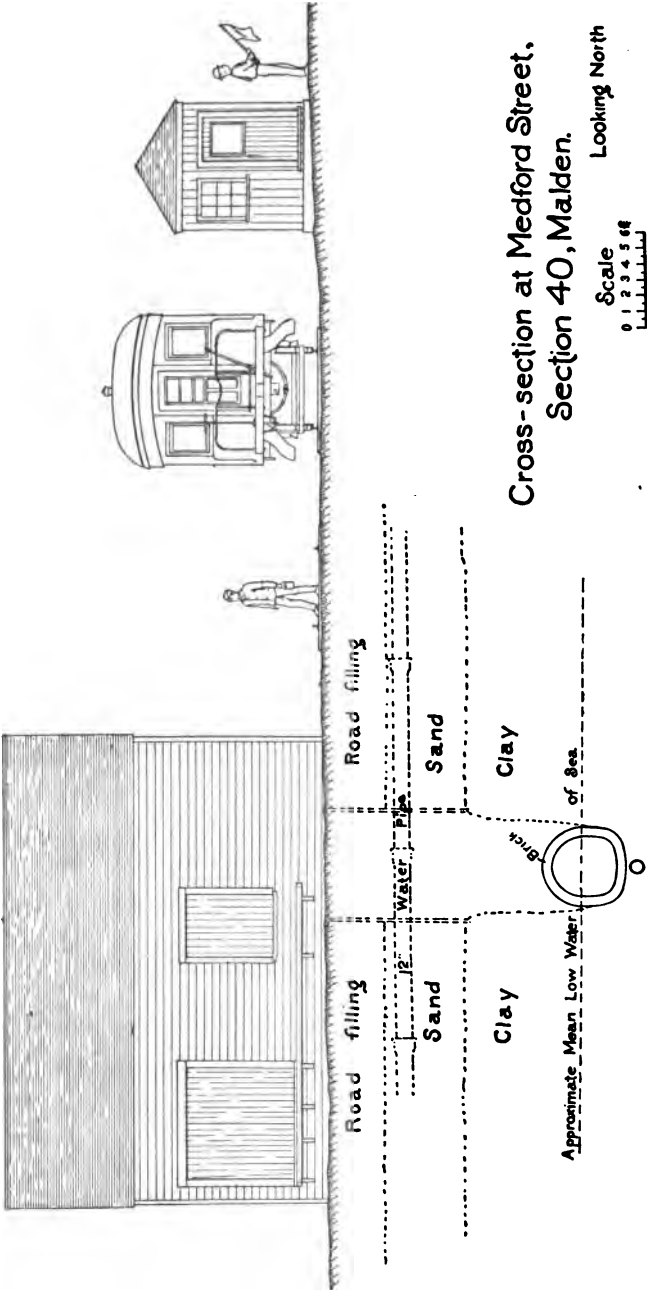
Average width top of trench, ... 7.50 “

Average width bottom of trench, ... 7.30 “

Cubic yards excavation per linear foot, 4.10.

Approximate cost of trench per linear foot, including
sheeting left in, excavation and refilling below grade,
etc, \$4.90.

Character of Earth Excavation. — Through peat, sand, clay and gravel; some silt has been found; the sewer rests mainly upon firm clay.



Masonry.

Contract price:—

Brick-work, American cement mortar, per cubic yard, . . .	\$12 00
Brick-work, Portland cement mortar, per cubic yard, . . .	13 75
Concrete, American cement mortar, per cubic yard, . . .	5 75
Concrete, Portland cement mortar, per cubic yard, . . .	7 00
Approximate cost of masonry per linear foot, including plat-	
form, underdrain, etc., ...	5 90
Length completed, ...	4,375 feet.

Masonry begun, Oct. 5, 1891, and is now in progress.

Approximate cost of section per linear foot of trench and masonry,
including labor, material, inspection and miscellaneous
items, ... \$12 00

Excavation.—A trench machine has been used. Work was begun at the lower end, Sept. 24, 1891, and has now reached a point about 350 feet westerly from the old bed of Malden River. For three-quarters of the distance a four-inch pulsometer and a hand pump was used. A six-inch pump, located 1,000 feet south of Bell Rock station, and later moved to near this station, has been employed for the remainder of the distance built to date. Six, eight, ten and twelve inch underdrain has been used.

Foundation.—The bottom of the trench was excavated to fit the invert of the sewer for the first 1,800 feet and for a length of 940 feet between West Everett and Bell Rock stations, also for 400 feet from Bell Rock to Malden River. Near the old bed of Malden River silt averaging about 5 feet in depth below sewer grade has been removed and a bed of gravel placed upon the underlying sand and gravel, to serve as a foundation for the sewer.

Difficulties.—The sewer passes under the old bed of the Malden River, and for a distance of about 100 feet the eight-inch brick-work of the sewer has been entirely surrounded by Portland concrete. This concrete is 2 feet in thickness over the arch. The outer end of the large stone culvert built at this point by the Boston & Maine Railroad has been removed, and will later be replaced.

Progress.—With the full gang working, its ordinary progress per week has been 95 feet. There have been so

many changes in the organization of the working force that at times the progress has been very unsatisfactory. The trench has several times been flooded by high tides and storms, causing short delays in the work.

Miscellaneous. — In accordance with an agreement with the Boston & Maine Railroad, the width of the taking was fixed at 6 feet, and several slight changes in the sewer line were made to bring the sewer into the centre of this strip. Since work started on this section the Boston & Maine Railroad has double-tracked the Saugus Branch Railroad, which renders access to the section more difficult than before. The shallowest point on the section has 11 feet of filling over the arch. When completed, an embankment will have been built over nearly the whole length of the section of 2 feet in height above the marsh level.

SECTION 41 (CONTRACT WORK), MALDEN AND MELROSE.

Location. — From a point near the junction of Charles and Middlesex streets, Malden, through Middlesex and Dartmouth streets to near the yard of the Cochrane Worsted Mill. The work in the space intervening between this point and Mountain Avenue is done by day labor. From Mountain Avenue east of Spot Pond Brook the contract work proceeds through private and railroad land in Malden and Melrose, passing near to and in the rear of Middlesex Fells station to Goodyear Avenue, thence across the Boston & Maine Railroad and alongside the brook to Pleasant Street near Gould, through Pleasant Street to Wyoming Avenue, Melrose.

Length of section, ... 9,780 feet.

Diameters of sewers and length of each size: —

2 feet 1 inch by 3 feet 2 inches, ... 1,750 "

1 foot 10 inches by 2 feet 9 inches, ... 3,030 "

1 foot 8 inches by 2 feet 6 inches, ... 5,000 "

Contractors. — Moulton & O'Mahoney of Boston, Mass.

Contractors' Superintendent. — P. Kelley.

State Assistants.

Assistant Engineer: Wilbur F. Goodrich.

Inspector: Guy C. Emerson.

Transitmen: Assistants — Edward F. Adams, Alfred D. Allen.

Trench.

Length completed,	1,162.00 feet.
Average depth of excavation to bottom of underdrain,	13.30 "
Greatest depth of excavation to bottom of underdrain,	18.00 "
Average width top of trench,	5.00 "
Average width bottom of trench,	5.00 "
Cubic yards excavation per linear foot, 2.50.	
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below grade, etc., \$1.90.	

Character of Earth Excavation. — Gravel, bowlders, filling, sand, very fine sand with plenty of water.

Masonry.

Contract price: —

Brick-work, American cement mortar, per cubic yard,	\$14 50
Brick-work, Portland cement mortar, per cubic yard,	17 00
Concrete, American cement mortar, per cubic yard,	6 50
Concrete, Portland cement mortar, per cubic yard,	8 50
Approximate cost of masonry per linear foot, including under- drain, etc.,	2 20
Length completed,	1,127 feet.

Masonry begun, July 25, 1892, and is now in progress.

Approximate cost of section per linear foot of trench and masonry,
including labor, material, inspection and miscellaneous items, \$4 60

Excavation. — No hoisting machinery has been used. Operations began July 18, 1892, at a point about 160 feet north of Mountain Avenue, and have now reached a point about 100 feet south of Ripley Street. The trench has been kept free from ground-water by the use of one six-inch pump and two hand pumps, together with four, six and eight inch underdrain. Very fine sand has been packed over the arch from a point 175 feet south of Clifton Street to the end of the year's work. This has been done in order that the fine particles of the sand may sift into any interstices in the masonry, and thus lessen percolation.

Foundation. — The bottom of the trench has been excavated to fit the invert of the sewer from a point 160 feet north of Mountain Avenue for a length of 204 feet toward the end of the section. Quicksand has been encountered from a point 100 feet south of Clifton Street to the end of

the year's work. For 450 feet of this length one-inch cradling lined with tarred paper has been used, and for the rest of the way cradling with two thicknesses of boards and tarred paper between.

Progress.—One gang has been employed. Its ordinary progress per week, with the full force working, has been 113 feet. The work has been carried on without interruption.

SECTION 41 (DAY WORK), MALDEN.

Location.—From the head of Dartmouth Street, through private land pond of Cochrane Carpet Company, private land, Cochrane Reservoir and private land to Mountain Avenue.

Length of section, ... 1,020 feet.

Diameters of sewers and length of each size:—

2 feet 1 inch by 3 feet 2 inches, ... 320 "

1 foot 8 inches by 2 feet 6 inches, ... 700 "

Assistants.

Assistant Engineer and Inspector: Wilbur F. Goodrich.

Foremen: Michael Tallent, B. L. Sykes.

Transitmen: Assistants—Edward F. Adams, Alfred D. Allen.

Trench.

Length completed, ... 900.00 feet.

Average depth of excavation to bottom of underdrain, ... 7.00 "

Greatest depth of excavation to bottom of underdrain, ... 9.00 "

Average width top of trench, ... 4.17 "

Average width bottom of trench, ... 4.17 "

Cubic yards excavation per linear foot, 1.00.

Character of Excavation.—Gravel, sand and rock, and under two millponds.

Masonry.

Length completed, ... 888 feet.

Masonry begun, June 14, 1892, and is now in progress.

Approximate cost of section per linear foot of trench and masonry, including labor, material, inspection and miscellaneous items, \$10 10

Excavation.—The excavated earth has been thrown out by hand. At the ledge a machine called an incline was used in connection with a steam hoist to take out the rock. Work began June 9, 1892, at a point near the Cochrane Carpet Company's gate, at the head of Dartmouth Street, and has

nearly reached Mountain Avenue. There are about 50 feet of unfinished ledge work between the ponds. A six-inch steam pump, a hand pump, and six and eight inch under-drain have been used in dealing with the water encountered.

Foundation.—For a short distance in the lower pond of the Cochrane Carpet Company excavation was made below sewer grade to a depth of about one foot and refilled with gravel.

Difficulties.—There was heavy ledge work between the upper and lower ponds of the Cochrane Company. Light coffer-dams were required in building through these ponds; concrete masonry was built around the sewer, and the sheeting left in. On the stream side of the lower pond a rubble wall, 18 inches wide at top with a slope of face of $1\frac{1}{2}$ to 1 to solid bottom, was laid. The retaining wall west of the lower pond was found bulged and out of shape before our operations began, but was not injured at all by the sewer work.

Progress.—One gang has been employed, and its ordinary progress per week, with the full force working, has been about 45 feet. The work has been carried on without interruption.

SECTION 42, MELROSE AND STONEHAM.

Location.—From a point in Wyoming Avenue, opposite Pleasant Street in Melrose, to a point in the same street in Stoneham, about 50 feet beyond the town line.

Length of section, ... 3,050 feet.

Diameter of sewer, 1 foot (vitrified bell pipe).

Contractor.—David L. Clements of Cleveland, O.

Contractor's Superintendent.—John Carlson.

State Assistants.

Assistant Engineer: Wilbur F. Goodrich.

Inspectors: B. L. Sykes, James W. Murray.

Transitmen: Assistants—Edward F. Adams, Alfred D. Allen.

Trench and Pipe.

Length of trench completed, ... 1,015.00 feet.

Length of pipe laid, ... 804.00 "

Average depth of trench excavation to bottom of under-drain, ... 12.80 "

Greatest depth of trench excavation to bottom of under-drain, ... 14.50 "

Average width top of trench, ...	4.00 feet.
Average width bottom of trench, ...	3.00 "
Cubic yards excavation per linear foot of trench, 1.70.	

Pipe work begun, Aug. 15, 1892, and is now in progress.

Character of Earth Excavation. — Street material filling, sand and very fine sand. Most of the earth has been saturated with water.

Masonry.

Contract price: —

Brick-work, American cement mortar, per cubic yard, . . .	\$16 00
Brick-work, Portland cement mortar, per cubic yard, . . .	18 00
Concrete, American cement mortar, per cubic yard, . . .	5 00

Approximate cost of section per linear foot of trench and pipe,
including labor, material, inspection and miscellaneous items, \$2 10

Excavation. — The excavated earth has been thrown out by hand. The first opening was commenced July 30, 1892, at a point in Wyoming Avenue, opposite Pleasant Street in Melrose, and the work progressing westerly is now going on at Cottage Street. A second opening was started September 12, at a point about 50 feet west of Lynde Street. The work proceeding from this latter opening is now in progress at a point about 120 feet westerly from Whittier Street. Two hand pumps and one steam pump, together with four-inch and six-inch underdrain, have kept the trench clear of ground-water.

Foundation. — For the first 124 feet of the section the twelve-inch pipe sewer is laid in fine wet sand. A four-inch underdrain entirely surrounded with gravel is placed below it. Thence for a distance of 402 feet a lively quicksand was encountered at sewer grade, which rendered it unsafe to lay the pipe directly on the sand. The quicksand was excavated to fifteen inches below the sewer, and at that depth a curved cradle, of inch boards supported on two-inch by three-inch ribs, 4 feet apart, was laid. The cradle had a spread of 2 feet and a dip of 9 inches. A six-inch underdrain was laid in the cradle, and the whole backfilled with broken stone and pea gravel to 3 inches below the twelve-inch pipe, which was then laid in firm sand. To prevent any lateral movement of the pipe, the sheeting of the trench was left in place

for several feet above the pipe. To avoid any possibility of quicksand entering the pipe, a hemp gasket was firmly driven into the Portland cement of the pipe joint.

Progress. — Two gangs have been employed. With the full force working, the ordinary progress per week has been 48 feet at the opening first started, and 107 feet at the second opening.

TABLE OF PROGRESS.

The following table recapitulates to some extent the detailed information given in this report and those of preceding years: —

TABLE OF CONTENTS

[illegible]

17, Everett, . . .	Christy McBride, . . .	5' 10" X 6' 4", 4' 8" X 5' 1", . . .	21 4	2,936	Sept. 30, 1892.
17½, Everett, . . .	Metropolitan Construction Co., . . .	4' 8" X 5' 1", 4' 8" X 5' 1", 4' 5" X 4' 8", . . .	17	1,627	Sept. 30, 1892.
20, Medford, . . .	John Sheehan, . . .	{ Edgeworth branch, 2', . . .	15	6,030	Apr. 30, 1893.
21, Medford, . . .	National Construction Co., . . .	4' 5" X 4' 8", 4' 3" X 4' 6", . . .	15	8,030	Feb. 28, 1893.
22, West Medford, . . .	Andrew W. Bryne, . . .	3' 4" X 3' 6", . . .	14	2,120	June 30, 1893.
23, Everett, . . .	R. A. Malone & Sons, . . .	6' X 6' 8", . . .	18	1,815	Sept. 30, 1892.
24, Everett and Charlestown, . . .	Metropolitan Construction Co., . . .	6' X 6' 8", . . .	25	2,332	Sept. 30, 1892.
26, Ch'town and Somerville, . . .	Harry P. Nawn, . . .	6' 6" X 7' 2", 5' 9" X 6' 6", . . .	23.2*	1,616	Nov. 30, 1893.
26,†, Somerville, . . .	Day work, . . .	5' 9" X 6' 6", . . .	32†	445	-
27, Somerville and Camb'dge, . . .	McGovern & Kitch, . . .	5' 9" X 6' 6", 5' 2" X 5' 9", . . .	35†	593	Aug. 31, 1893.
40, Everett and Malden, . . .	R. A. Malone & Sons, . . .	3' 9" X 4' 1", . . .	23.50	4,375	Aug. 31, 1892.
41, Malden and Melrose, . . .	Moulton & O'Mahoney, . . .	2' 1" X 3' 2", 1' 10" X 2' 9", 1' 8" X 2' 6", . . .	16.4	1,127	Sept. 29, 1893.
41, Malden, . . .	Day work, . . .	2' 1" X 3' 2", 1' 8" X 2' 6", . . .	13.3	888	-
42, Melrose and Stoneham, . . .	David L. Clements, . . .	1' pipe, . . .	7	804	Nov. 30, 1892.*

* Trench.

† Tunnel.

‡ Part of.

TABLE OF SEWER WORK COMPLETED AND IN PROGRESS SEPT. 30, 1892.

Section.	LOCALITY.	NAME OF CONTRACTOR.	Total Length of Section. Feet.	SIZE OF SEWER.	Average Depth of Trench, Bottom of Underlain or Deeper Excava- tion. Feet.	Length of Sewer completed Sep- tember 30. Feet.	Date of Comple- tion named in Contract.
A,	Boston,	Built by city of Boston,	1,897	6'6",	23	1,897	May, 1890.
B,	Boston,	H. C. Eyre,	3,701	5'6",	20.3	3,701	Aug. 31, 1891.
C,	Boston and Brookline,	H. C. Eyre,	2,965	5'6",	18.5	2,965	Feb. 28, 1891.
D,	Brighton,	National Construction Co.,	5,787	4'10" X 5'3",	16.4	5,787	Aug. 31, 1891.
E,	Brighton,	National Construction Co.,	5,300	4'10" X 5'3",	17.2	5,300	July 31, 1891.
F,	Brighton,	Jones & Meehan,	8,027	4'6" X 5'1",	14.7	8,027	Nov. 30, 1891.
G,	Newton and Watertown,	Jones & Meehan,	7,673	4'2" X 4'9", 3'11" X 4'5",	10.4	7,673	Nov. 30, 1891.
H,	Newton,	Jones & Meehan,	2,800	3'11" X 4'5", 3'6" X 4",	19.1	2,800	Nov. 30, 1891.
I,	Newton,	Metropolitan Construction Co.,	4,517	3'6" X 4",	13.7	4,500	Nov. 30, 1891.
2,	Deer Island,	National Construction Co.,	2,136	{ Outfall sewer, 6' X 6' to 6' X 10', Main sewer, 9'1",	17	2,120	Feb. 29, 1892.
3,	Deer Island,	R. A. Malone & Co.,	2,641	9'1",	28	2,641	Apr. 30, 1891.
4,	Winthrop,	Metropolitan Construction Co.,	5,710	9'1",	26	5,710	June 30, 1891.
5,	Winthrop,	Metropolitan Construction Co.,	4,600	9'1",	22	4,600	July 31, 1891.
6,	Winthrop,	Metropolitan Construction Co.,	4,113	9'1",	16	4,113	May 31, 1891.
7,	Winthrop and E. Boston,	Trumbull & Ryan,	848	{ Main sewer, 8'6" X 9'2", Sand catcher, 16' X 16'5",	7.55	370	June 1, 1893.
8,	Breed's Island,	Charles Linehan,	4,126	9' X 9'2", 8'6" X 9'2",	14	4,126	Aug. 31, 1891.
9,	East Boston,	Charles Linehan,	3,383	9' X 9'2", 8'6" X 9'2",	16.4	3,383	May 31, 1891.
10,	East Boston and Chelsea,	Day work,	660	8'4" X 9'2",	15.8	Surface only,	Apr. 30, 1893.
12,	Chelsea,	Orin P. Roberts,	3,024	8'4" X 9'2",	27	2,237	Apr. 30, 1893.
14,	Chelsea,	Metropolitan Construction Co.,	3,445	8'10", 8'4" X 9'6", 8'4" X 9', 8'2" X 8'10",	{ 29* 37†	2,003	Dec. 30, 1893.
15,	Chelsea,	Christy McBride,	1,764	8'2" X 8'10",	23.2	1,764	May 31, 1892.
16,	Everett,	R. A. Malone & Son,	4,432	{ 8'2" X 8'10", 5'10" X 6'4",	19 20	3,121	Nov. 30, 1892.

17,	Everett,	.	.	.	.	.	5' 10" X 6' 4", 4' 8" X 5' 1",	.	.	.	21 4	2,936	Sept. 30, 1892.
17 ¹ / ₂ ,	Everett,	.	.	.	.	.	4' 8" X 5' 1",	.	.	.	17	1,627	Sept. 30, 1892.
20,	Medford,	.	.	.	.	.	{ Main line, 4' 8" X 5' 1", 4' 5" X 4' 3",	.	.	.	18	6,030	Apr. 30, 1893.
21,	Medford,	.	.	.	.	.	{ Edgeworth branch, 2',	.	.	.	15	8,030	Feb. 28, 1893.
22,	West Medford,	.	.	.	.	.	4' 5" X 4' 8", 4' 3" X 4' 6",	.	.	.	14	2,120	June 30, 1893.
23,	Everett,	.	.	.	.	.	3' 4" X 3' 6",	.	.	.	18	1,815	June 30, 1892.
24,	Everett and Charlestown,	.	.	.	.	.	6' X 6' 8",	.	.	.	24.5	2,332	Sept. 30, 1892.
26,	Ch'town and Somerville,	.	.	.	.	.	6' X 6' 8",	.	.	.	25	1,616	Nov. 30, 1893.
26 ¹ / ₂ ,	Somerville,	.	.	.	.	.	6' 6" X 7' 2", 5' 9" X 6' 6",	.	.	.	{ 23 2*	445	-
27 ¹ / ₂ ,	Somerville and Cambridge,	.	.	.	.	.	5' 9" X 6' 6",	.	.	.	{ 32†	593	Aug. 31, 1893.
40,	Everett and Malden,	.	.	.	.	.	5' 9" X 6' 6", 5' 2" X 5' 9",	.	.	.	23.50	4,375	Aug. 31, 1892.
41,	Malden and Melrose,	.	.	.	.	.	3' 9" X 4' 1",	.	.	.	16.4	1,137	Sept. 29, 1893.
42,	Melrose and Stoneham,	.	.	.	.	.	2' 1" X 3' 2", 1' 10" X 2' 9", 1' 8" X 2' 6",	.	.	.	13.3	888	-
		.	.	.	.	.	2' 1" X 3' 2", 1' 8" X 2' 6",	.	.	.	7	804	Nov. 30, 1892.
		.	.	.	.	.	1' pipe,	.	.	.	12.8		

* Trench.

† Tunnel.

‡ Part of.

EXAMINATIONS, CEMENT TESTING.

As has been stated in previous reports, careful and oft-repeated examination of the sewer work is made during its progress and as fast as portions are completed, to discover cracks, settlements, changes of shape, leaks and other imperfections. This careful scrutiny is made with the intent to remedy such imperfections as occur, and to lessen the chances of their occurring on the work to be done.

About 96,000 barrels of American natural cement and 32,000 barrels of imported Portland cement have been used during the year. About 13,000 tests have been made in this time, to aid in rejecting such kinds as were not adapted to our work. The most weight has been given to those tests in which the sand and cement were mixed in the proportions customary in the sewer masonry. The briquettes are subjected, as nearly as is practicable, to the conditions met with in actual use. The sand has been mostly what is known as skimming sand. Particles so fine as to pass through a sieve having 625 meshes to the square inch, and those so coarse as to be retained by a sieve having 100 meshes to the square inch, have been thrown out. Frequent experiments with other sands used on the work have been made for comparison, and comparisons have also been made with crushed quartz. It is well known by those who have had experience in cement testing that variations in the quality of sand, in the proportions of water, in the temperature of the materials and the surrounding medium and the solidity of the packing, affect the strength of the specimens. In order to make these conditions as nearly uniform as practicable, nearly all of the briquettes have been made by the same person, and one person has been employed to break them. To the same end, a trip-hammer was built, similar to that devised by Dr. Böhme, by means of which the mortar, after being mixed by hand in the proper proportions, is packed into the moulds. The effective weight of the hammer is $8\frac{1}{2}$ pounds, and the fall is $7\frac{1}{2}$ inches. The fall being due to gravity only, and always through the same distance, perfect uniformity of the blows



Hammer for tamping cement briquettes.

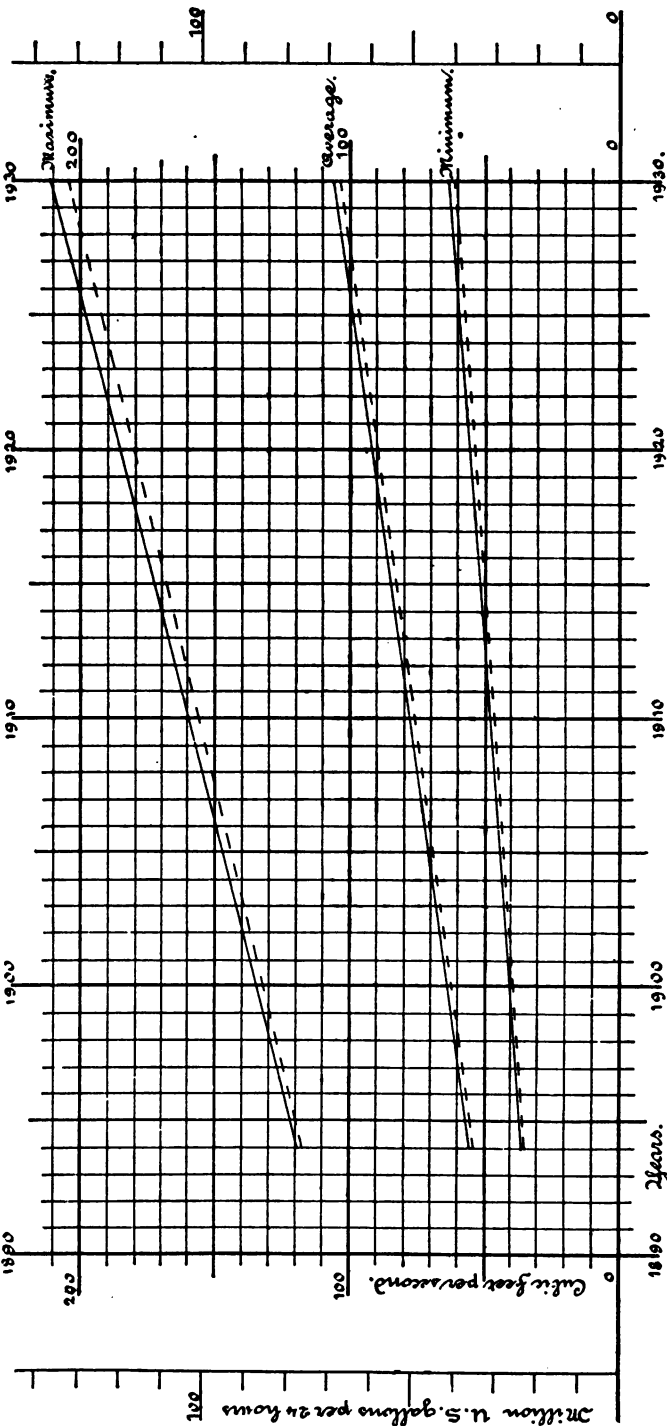
is insured. The machine is run at the rate of 100 blows per minute, by a small, constant-speed electric motor, and is furnished with an automatic counting apparatus which can arrest its motion after any desired number of blows. It was found that 35 blows for each briquette would give about the same strength as those tamped by hand. This number of blows was therefore taken as a standard. Various tests by the use of steam and hot water have been made. As in the past, our own tests and studies have been supplemented by those of practical, experienced and scientific men elsewhere. Information regarding cement masonry in place for considerable periods of time in different localities has been obtained by examinations and by addressing inquiries to parties familiar with the facts in each case.

ESTIMATED QUANTITY OF SEWAGE.

The sizes of sewers in the preliminary design of the Metropolitan system were based on the estimates of population made by the State Board of Health (see Senate Document No. 2, January, 1889, page 41). These estimates were based upon the census of 1885 and those of earlier years. After the work of construction of the system was begun the figures derived from the census of 1890 showed that the population of the district was growing more rapidly than had been indicated by the earlier census. The estimate of the population in 1930 was therefore revised and increased. The estimated amount of sewage for 1930, as given in the above-mentioned Senate Document, is about ten per cent. less than that finally adopted. The sizes of the sewers in our system have been accordingly increased, adding somewhat to the cost of construction.

The maximum rate of flow is taken at 35 cubic feet, or 262 gallons, per head per day for Somerville and Cambridge, and at 30 cubic feet, or 224 gallons, per head per day for all other cities and towns.

The average rate of flow is taken at 110 gallons per head per day for the population of 1890, and at 120 gallons per head per day for the anticipated population of 1930; the population and rate of flow being considered to increase at a uniform ratio between these years.



Estimated rates of flow of sewage at the pumping stations at Deer Island and East Boston.
Deer Island, full lines.
East Boston, broken lines.

The minimum rate of flow is taken at two-thirds the average flow in dry seasons. This ratio is derived from some observations upon the flow of sewers in Providence. The average flow in dry seasons is estimated at 117 gallons per head per day in city districts, and at 85 gallons per head per day in suburban districts (see page 95 of the above-mentioned Senate Document). The minimum rate of flow is therefore taken at 78 gallons per head per day for Boston, Charlestown, East Boston, Chelsea, Somerville and Cambridge, and at 57 gallons per head per day for all the other cities and towns. Reports of the flow of sewage at the Boston main drainage pumping station indicate that the minimum rate of flow in 1889 at that place was about 82 gallons per head per day. The rates of flow of sewage at the several pumping stations are computed on the supposition that the entire estimated population is connected with the sewers.

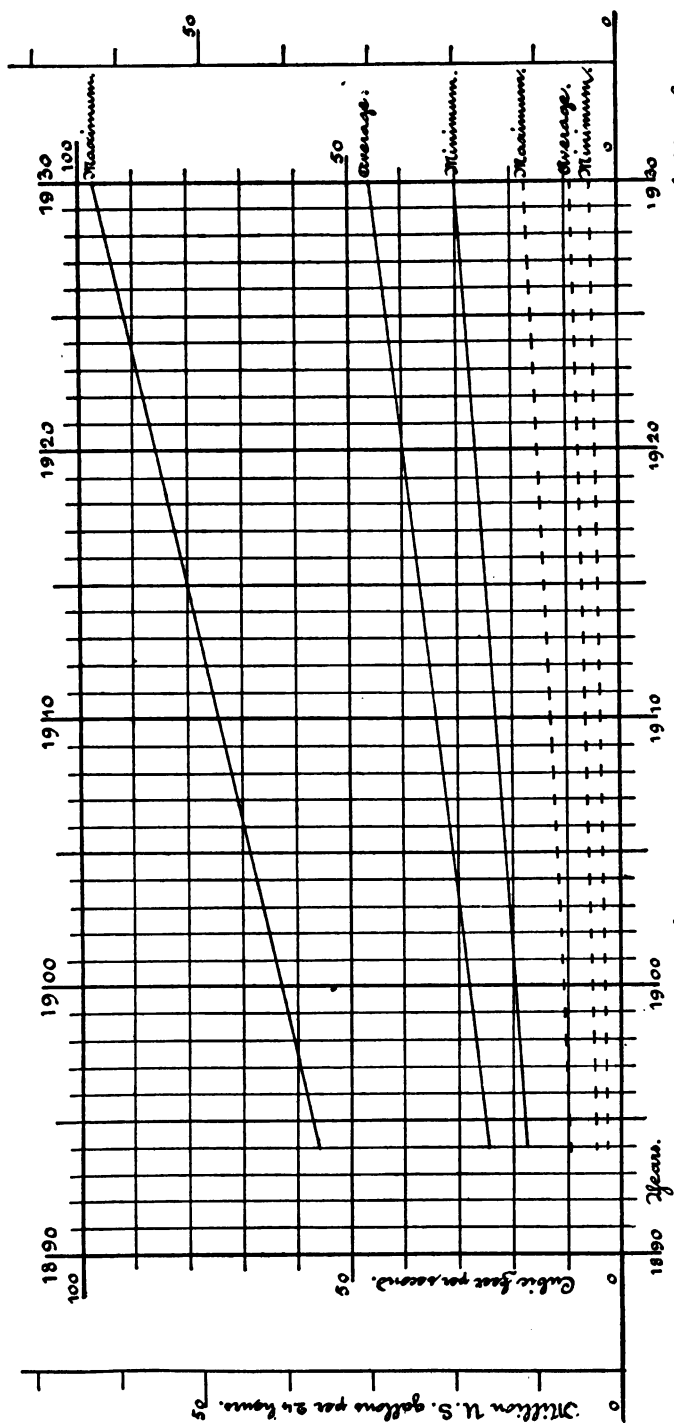
Appended diagrams show the estimated rates of flow for a period of forty years at the pumping stations of the North Metropolitan system in cubic feet per second and also in million gallons per twenty-four hours.

COST.

As stated in the report for last year, some sections of the Metropolitan sewerage system have cost more than the original estimate and others have cost less. The aggregate cost of those parts now completed appears to exceed by about 3 per cent. the original estimate. In last year's report it was stated that a careful comparison of prices bid for different classes of work on the Metropolitan sewers before and after June 1 of that year showed a marked advance in the later lettings. The advance then noted has been maintained this year.

As has already been stated, the sizes of the sewers in the Metropolitan system have been increased, and the carrying capacity of the system as a whole will be about 10 per cent. larger than shown in the design on which the original estimate of cost was based.

The foregoing comparisons of estimated and actual cost include engineering and construction but do not include



land damages. I am unable to make any statement at present as to how the actual land damages will compare with the original estimate.

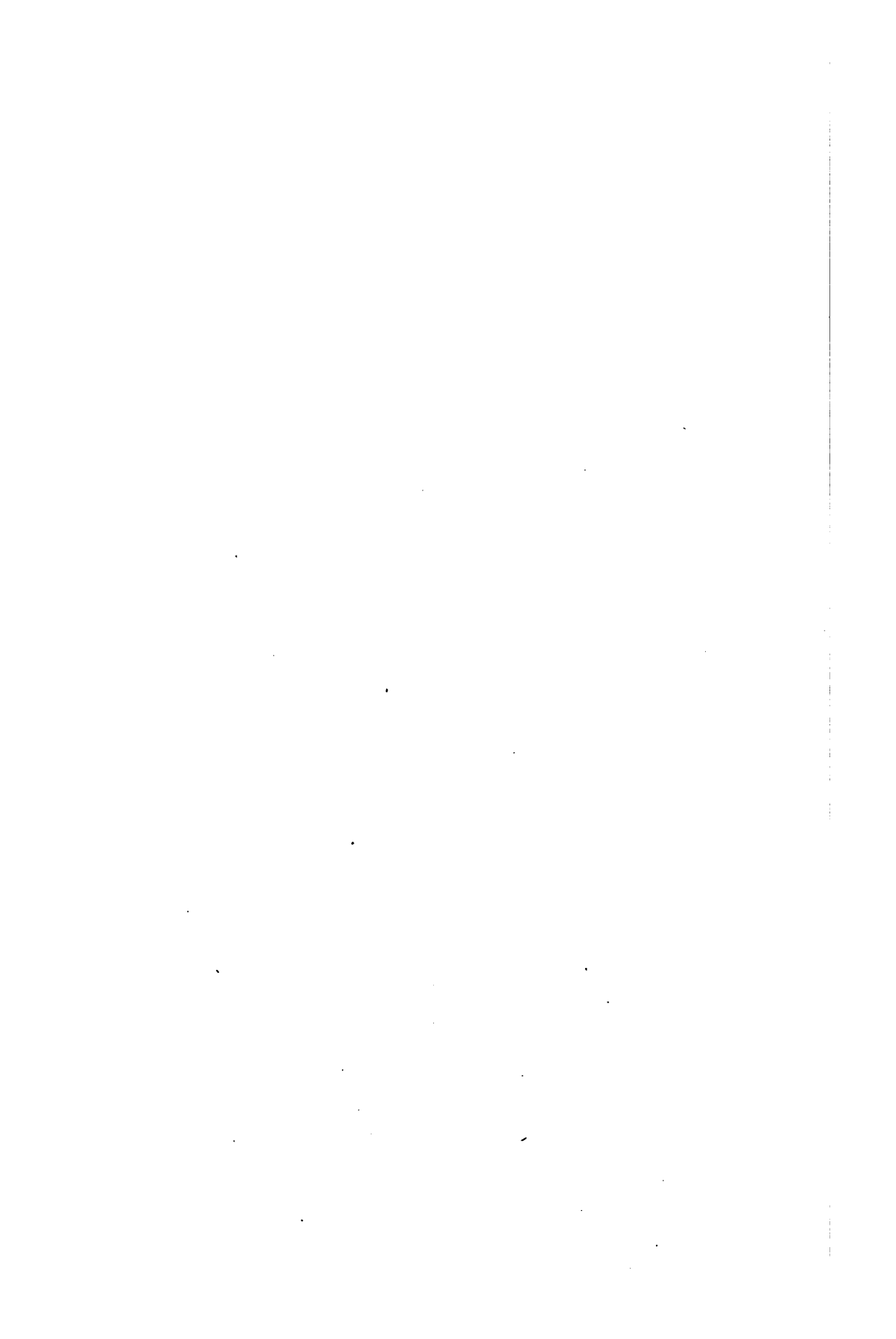
WHEN WILL THE METROPOLITAN SEWERAGE SYSTEM BE
COMPLETED?

The foregoing question is often asked. The Charles River valley system, as has been already stated, was complete and in operation last spring. The difficulty of predicting when the North Metropolitan system will be done can readily be seen. Months of hard labor have been expended at some points on our work, as on parts of sections 12 and 14, for example, without gaining a foot of ground in advancing the sewer. Numerous other obstacles of equal difficulty will doubtless again occur. It required about six and one-half years to construct the principal part of the Boston main drainage system, whose whole extent is shown on the progress map included in this report. The work of our system is at least as difficult and is much more extensive than that. If it should require the same length of time to complete the Metropolitan system, our work would be finished in December, 1896; or, if we assume that the rate of progress indicated in the opening paragraph of this report will be maintained in the future, it can easily be calculated that the entire work will be finished in the fall of 1894; but some of the work yet to be done is of quite a different character from that which has preceded, and such a prediction cannot be safely made.

Respectfully submitted,

HOWARD A. CARSON,

Chief Engineer.



APPENDIX.

TABLE A.
BIDS FOR CONSTRUCTION OF SECTIONS UPON NORTH METROPOLITAN SYSTEM.

NAMES OF BIDDERS.	Residence.	BIDS OPENED NOV. 4, 1891.			BIDS OPENED JAN. 30, 1892.		BIDS OPENED FEB. 27, 1892.	
		SECTION 21.	SECTION 22.*	SECTION 24.	SECTION 22.	SECTION 13.*	SECTION 14.	
		Medford.	Medford.	Everett and Charlestown.	Medford.	Chelsea.	Chelsea.	
Jones & Meehan, ...	Jamaica Plain, .	\$98,270 00	\$105,350 00	\$61,190 00	\$73,877 50	\$176,812 50	\$166,180 00	
Collins & Ham, ...	Boston, ...	88,438 00	-	47,572 00	-	-	-	
Bernard E. Malone, ...	Lancaster, Pa., .	83,432 50	59,100 00	41,622 50†	-	-	-	
Dennis O'Connell, ...	Dorchester, . . .	81,972 50	-	-	-	-	-	
Metropolitan Construction Company, ...	Boston, ...	79,998 50	71,002 30	42,874 00†	83,191 50	173,753 60	148,856 70†	
Albert A. Libby & Co., ...	Boston, ...	75,308 00	-	-	-	-	-	
H. P. Nawn, ...	Boston, ...	77,790 00	-	-	-	-	-	
National Construction Company, ...	Boston, ...	76,239 00†	79,027 50	45,980 00	-	228,398 20	-	
John J. Dwyer, ...	Somerville, . . .	-	-	-	86,045 00	-	-	
Andrew W. Byrne, ...	Somerville, . . .	-	-	-	66,740 00†	-	-	
Charles G. Upham, ...	Chelsea, ...	-	-	-	-	-	-	
Everett & Lidd, ...	Providence, R. I.,	-	-	-	-	213,145 70	177,159 30	
Hart, Adams & Barr, ...	Brooklyn, N. Y.,	-	-	-	-	174,370 00	150,908 00	
Arden A. Hall, ...	Boston, ...	-	-	-	-	-	203,598 00	
Empire Construction Company, ...	New York, ...	-	-	-	-	-	185,673 50	
							176,460 00	

* All bids on this section rejected.

† Bid rejected.

‡ Contract awarded to.

TABLE A — Concluded.

NAMES OF BIDDERS.	Residence.	BIDS OPENED APRIL 2, 1892.	BIDS OPENED MAY 7, 1892.	BIDS OPENED JUNE 4, 1892.	BIDS OPENED JUNE 25, 1892.	BIDS OPENED JULY 16, 1892.	BIDS OPENED SEPT. 10, 1892.
		SECTION 26. Charlestown and Somerville.	SECTION 27. Somerville and Cambridge.	SECTION 41. Malden and Melrose.	SECTION 7. Winthrop and East Boston.	SECTION 42. Melrose and Stoughton.	SECTION 34.* Shirley Gut.
Jones & Meehan.	Jamaica Plain.	\$90,470 00	\$71,685 00	\$79,170 00	\$51,625 00	-	-
Dennis O'Connell.	Dorchester.	-	-	-	-	\$6,840 00	-
Metropolitan Construction Company.	Boston.	97,662 50	65,430 50	48,341 00	-	-	-
Albert A. Libby & Co.,	Boston.	-	75,682 00	-	-	-	-
H. P. Nawn.	Boston.	76,740 00†	66,362 50	-	-	-	-
National Construction Company.	Boston.	94,244 00	71,125 00	40,971 50	82,410 00	5,767 50	\$119,396 00
Charles G. Craib.	Chelsea.	-	69,780 00	-	-	-	-
Everson & Liddle.	Providence, R. I.,	94,520 00	68,115 00	69,825 00	-	-	-
Aaron A. Hall.	Boston.	92,766 80	-	-	-	-	-
John J. Dorey and Jeremiah McCarthy.	Somerville.	115,685 00	-	-	-	-	-
James J. Newman.	Providence, R. I.,	-	90,412 50	-	-	-	-
Christy McBride.	Brighton.	-	86,845 00	63,806 00	-	-	-
DeLafield Construction Company.	New York.	-	74,000 00	-	-	-	-
McGovern & Kitch.	Lancaster, Pa.,	-	55,240 00†	-	-	-	-
Franklin A. Snow.	Providence, R. I.,	-	-	68,756 00	-	7,290 00	-
John Sheehan.	Lynn.	-	-	68,609 00	61,670 00	8,542 50	-
Monilton & O'Mahoney.	Boston.	-	-	38,380 00†	-	-	-
William H. Ward.	Lowell.	-	-	-	-	-	-
Trumbull & Ryan.	Boston.	-	-	-	-	-	-
David L. Clements.	Waltham.	-	-	-	-	-	-
Whittridge & Pevear.	Lynn.	-	-	-	-	5,233 00†	-
George M. Byrne.	West Medford.	-	-	-	-	5,942 00	-
John McNamee.	Brooklyn, N. Y.,	-	-	-	-	7,400 00	66,000 00
John Cavanaugh & Co.,	Boston.	-	-	-	-	-	82,000 00
Breuchand, Fennell & Co.,	Yonkers, N. Y.,	-	-	-	-	-	62,400 00
Perkins & White (Woods Joint),	Boston.	-	-	-	-	-	54,500 00
Perkins & White (McNeil Pipe and Foundry Co. Joint).	Boston.	-	-	-	-	-	59,000 00

* All bids on this section rejected.

† Contract awarded to.

TABLE B.
NORTH METROPOLITAN SYSTEM.

Sec- TION.	Location.	Adver- tised for Bids.	Bids opened.	Num- ber of Bids.	Highest.	Lowest.	CONTRACT AWARDED TO —	Residence.	Amount of Contract.	Work began.	To be com- pleted.	Length of Section.
No. 21.	Medford, .	1891. Oct. 10.	1891. Nov. 4.	8	\$98,270 00	\$76,259 00	National Construction Co.,	Boston, .	\$76,259 00	1891. Nov. 16.	1892. Feb. 23.	8,060 ft.
No. 22.	Medford, .	Oct. 10.	Nov. 4.	4	105,350 00	59,160 00	<i>All bids rejected.</i>					
No. 24.	Everett and Charlestown.	Oct. 10.	Nov. 4.	5	61,190 00	41,622 50	Metropolitan Construction Co.,	Boston, .	42,874 00	Dec. 4.	1892. Sept. 30.	2,300 ft.
No. 22.	Medford, .	Dec. 5.	Jan. 30.	4	86,065 00	68,740 00	Andrew W. Byrne, .	Somerville, .	68,740 00	1892. Feb. 23.	1892. June 30.	6,080 ft.
No. 13.	Chelsea, .	1892. Jan. 23.	Feb. 27.	5	226,398 20	173,753 60	<i>All bids rejected.</i>					
No. 14.	Chelsea, .	Jan. 23.	Feb. 27.	7	203,596 00	148,856 70	Metropolitan Construction Co.,	Boston, .	148,856 70	Mar. 29.	Dec. 30.	8,440 ft.
No. 26.	Charlestown and Somerville.	March 5.	April 2.	7	115,685 00	76,740 00	H. P. Nawn, .	Boston, .	76,740 00	April 18.	Nov. 30.	4,330 ft.
No. 27.	Somerville and Cambridge.	April 9.	May 7.	11	90,412 50	55,240 00	McGovern & Kitch, .	Lancaster, Pa.,	55,240 00	June 6.	Aug. 31.	4,295 ft.
No. 41.	Malden and Mel- rose.	May 14.	June 4.	8	79,170 00	38,350 00	Moulton & O'Mahoney, .	Boston, .	38,350 00	July 18.	Sept. 29.	9,780 ft.
No. 7.	Winthrop and East Boston.	June 11.	June 25.	5	82,410 00	50,896 00	Trumbull & Ryan, .	Boston, .	50,895 00	July 5.	June 1.	820 ft.
No. 42.	Melrose and Stoneham.	June 27.	July 16.	7	8,542 50	5,233 00	David L. Clements, .	Waltham, .	5,233 00	July 30.	1892. Nov. 30.	8,060 ft.
No. 31.	Shirley Gut, .	Aug. 6.	Sept. 10.	6	119,396 00	54,500 00	<i>All bids rejected.</i>					
					\$1,276,455 20	\$849,379 80			\$563,217 70			

Length of sections contracted for, 42,098 feet = 7.973 miles. Diameter varies from a sewer 8 feet 4 inches by 9 feet to a 12-inch pipe sewer.

TABLE C.
CHARLES RIVER VALLEY SYSTEM.

SECTION.	Location.	Length of Section.	Built by —	Residence.	Work began.	Work accepted *.	Paid on Section to Date.	Amount re-served this Date.
Huntington Avenue Sewer,	Boston, . . .	1,900 feet.	City of Boston, . . .	. . .	1890. . .	1891. . .	\$59,076.00	-
A, . . .	Boston, . . .	3,700 "	Henry C. Eyre, . . .	Chester, Pa., . .	June 20, . . .	Nov. 11, . .	63,930 55	-
B, . . .	Boston, . . .	3,000 "	Henry C. Eyre, . . .	Chester, Pa., . .	July 1, . . .	Nov. 11, . .	41,762 10	-
C, . . .	Brighton, . . .	5,800 "	National Construction Co., . .	Boston, . . .	Sept. 1, . . .	Sept. 12, . .	76,353 20	\$200 00
D, . . .	Brighton, . . .	5,400 "	National Construction Co., . .	Boston, . . .	Sept. 8, . . .	Sept. 12, . .	46,144 02	300 00
E, . . .	Brighton, . . .	8,000 "	Jones & Meehan, . . .	Jamaica Plain, . .	1891. Mar. 20, . .	1892. April 9, . .	100,999 18	4,932 83
F, . . .	Newton and Watertown, . .	7,700 "	Jones & Meehan, . . .	Jamaica Plain, . .	Mar. 20, . . .	May 28, . . .	107,996 67	5,462 73
G, . . .	Newton, . . .	2,800 "	Jones & Meehan, . . .	Jamaica Plain, . .	June 5, . . .	Mar. 12, . . .	28,411 50	-
H, . . .	Newton and Waltham, . .	4,500 "	Metropolitan Construction Co., . .	Boston, . . .	Oct. 2, . . .	May 18, . . .	43,303 25	2,770 17

* Five per cent. (5 per cent.) of the amount of the contract is reserved for six months after the work has been accepted, to provide for sundry repairs, etc., that may be needed.

TABLE D.

MAINTAINING AND OPERATING CHARLES RIVER VALLEY
SEWER.

1892.	Dr.		
May 9,	To appropriation, made by chapter 281, Acts of 1892,	. . .	\$26,500 00
	Cr.		
July 2,	By amount paid city of Boston for receiving sewage and disposing of same, from Jan. 1, 1892, to July 1, 1892, under agreement dated April 13, 1892, .	\$11,500 00	
Aug. 12,	By amount paid for labor in operating Charles River system, ...	21 60	
Aug. 26,	By amount paid for labor, ...	63 84	
Aug. 21,	By amount paid Henry J. Wright, inspector in charge of system, one month's salary, ...	130 00	
Sept. 9,	By amount paid for labor, ...	66 84	
Sept. 21,	By amount paid Henry J. Wright, inspector, one month's salary, ...	130 00	
Sept. 10,	By amount paid for car fares and miscellaneous expenses of inspector, ...	14 48	
Sept. 28,	By amount paid for labor, ...	72 84	
Sept. 24,	By amount paid city of Boston under agreement of April 13, 1892, for receiving sewage and disposing of same from July 1, 1892, to Oct. 1, 1892, .	5,750 00	
			17,749 60
Oct. 1,	Balance, ...	. . .	\$8,750 40

EXPENDITURES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS TO SEPT. 30, 1892.

	Year ending Sept. 30, 1889.	Year ending Sept. 30, 1890.	Year ending Sept. 30, 1891.	Year ending Sept. 30, 1892.	Total.
Office expenses, ...	\$1,161 29	\$28,792 85	\$30,437 29	\$31,220 76	\$91,612 19
North Metropolitan system, ...	-	116,492 55	582,966 06	962,798 49	1,662,257 10
Charles River system, ...	-	18,329 41	381,149 33	280,308 29	679,787 03
Both systems, ...	-	2,696 20	5,597 86	7,703 15	15,997 21
	\$1,161 29	\$166,311 01	\$1,000,150 54	\$1,282,030 69	\$2,449,653 53

Total amount expended to Sept. 30, 1892, \$2,449,653.53.

METROPOLITAN SEWERAGE.

[Jan.

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR THE YEAR ENDING SEPT. 30, 1892.

[illegible]

Experts' and legal services, . . .	-	-	-	-	-	-	200 00	33 50	200 00	-	-	475 50
Blue printing, . . .	55	70 52	13 31	-	-	16 12	4 52	12 83	2 62	-	18 80	151 77
Photographic outfit, . . .	3 48	10 32	88 49	7 27	41 23	-	39 20	2 23	16 86	28 46	37 83	282 51
Cement testing: —												
Salaries, . . .	253 00	202 00	202 00	236 00	224 68	249 04	199 86	197 29	194 76	199 13	265 24	2,622 78
Rent of room, . . .	-	-	75 00	-	-	75 00	-	-	75 00	-	75 00	300 00
Furniture and machinery, . . .	-	-	-	-	-	-	75 90	149 81	-	72 45	6 56	304 71
Supplies, . . .	35	37 15	37 27	24 60	27 28	36 73	2 79	35 02	8 68	4 00	85 02	301 29
Experts' services, . . .	87 00	-	-	-	-	-	-	86 00	-	13 75	-	186 75
Travelling expenses, . . .	8 90	10 55	9 55	9 13	-	-	9 75	9 08	9 66	8 74	8 60	95 30
Grand totals, . . .	\$2,296 20	\$2,280 12	\$3,418 83	\$2,191 03	\$2,168 53	\$2,531 27	\$1,983 45	\$2,227 29	\$3,523 86	\$2,255 51	\$3,344 42	\$31,220 76

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR THE YEAR ENDING SEPT. 30, 1892.

Charles River System.

	1891.			1892.										Total.
	October.	Novem-ber.	Decem-ber.	January.	February.	March.	April.	May.	June.	July.	August.	Septem-ber.		
Salaries,—engineers, inspec- tors and others.	\$3,330 58	\$2,543 65	\$2,585 05	\$2,236 71	\$2,513 65	\$1,877 02	\$2,999 77	\$2,032 91	\$1,205 91	\$429 15	\$105 70	\$216 20	\$22,076 80	
Travelling expenses.	46 46	38 97	115 96	11 88	58 05	23 68	9 69	84 45	23 52	5 97	7 45	6 30	434 88	
Supplies, lumber, etc.,	28 02	297 21	62 91	190 02	1,877 95	486 98	206 70	503 97	108 76	24 43	29 95	157 74	3,474 63	
Manhole covers, flagstones, dimension stones, etc.,	71 08	-	168 00	350 91	-	26 80	-	52 22	1,392 68	631 12	-	-	2,690 31	
Postage, telegrams, express, etc.,	27 60	10 15	19 15	101 20	124 01	123 94	1 80	78 15	72 90	-	5 90	17 50	582 30	
Maps, plans and blue prints,	35	24 00	-	16 00	-	-	-	-	-	-	-	25	40 60	
Purchases and taking land, and recording same,	-	1 25	-	-	-	-	-	-	15 00	-	-	1 50	17 75	
Pipe, Muddy River, etc.,	365 25	-	-	326 83	236 80	41 47	-	-	-	-	-	-	686 10	
Gravel for filling,	-	-	-	47 19	-	-	-	-	-	1,197 65	-	-	1,562 90	
Changing hydrants,	-	-	-	-	-	-	-	-	-	-	-	110 09	187 88	
Covering sewer (Muddy River and other streams),	569 14	-	47 03	-	-	-	-	-	-	-	-	-	616 17	
Connecting sections B and C,	673 08	3,172 00	1,206 07	84 51	44 00	672 59	-	-	62 32	-	-	-	5,914 57	
Huntington Avenue sewer,	-	-	-	-	-	-	-	-	-	-	-	59,076 00	59,076 00	
Payments on account of con- tracts:—														
Henry C. Eyre,—														
Section A—Boston,	4,400 00	3,587 22	-	3,400 00	757 59	-	-	1,675 95	-	-	-	-	13,920 76	
Section B—Boston,	4,510 62	-	-	1,600 00	16 88	-	-	1,561 77	-	-	-	-	7,689 25	
National Construction Co.,—														
Section C—Brighton,	4,212 27	-	95 19	-	-	3,577 90	-	-	-	-	-	-	7,885 36	
Section D—Brighton,	1,780 25	-	-	-	-	2,007 22	-	-	-	-	-	-	3,787 47	

Jones & Meehan, — Section F — Brighton, Section F — Newton, Section F — Watertown, Section G — Newton, Metropolitan Const. Co., Section H — Newton and Waltham, ...	13,301 53	12,414 66	14,426 29	9,635 65	1,693 70	816 78	1,395 44	1,885 78	—	—	6 41	—	55,576 24
	10,517 10	8,609 02	3,217 21	6,614 '25	818 65	250 45	—	2,079 53	2,615 56	—	294 61	—	35,011 38
	5,080 58	3,625 59	2,829 90	—	—	365 66	1,756 59	348 84	—	—	—	1,378 28	15,584 94
	5,733 62	6,793 56	7,483 82	9,706 17	2,163 64	2,372 28	3,983 09	311 59	4,153 52	—	601 96	—	43,308 25
	\$54,647 53	\$41,117 28	\$32,254 58	\$34,320 82	\$9,797 90	\$12,642 27	\$10,353 08	\$10,614 66	\$9,655 16	\$2,288 32	\$1,051 98	\$60,964 46	\$279,708 04
Excess paid for cement on sections A, B, C and D during year, ...													600 25
													\$280,308 29

Both Systems.

Salaries, — engineers, inspectors and others, . . .	\$325 37	\$377 90	\$538 03	\$265 60	\$486 69	\$447 88	\$521 47	\$374 90	\$339 71	\$399 48	—	\$702 78	\$4,879 81
Travelling expenses, . . .	75	101 80	1 83	2 70	—	—	—	—	—	—	—	—	1 78
Supplies, ...	—	—	—	—	—	—	—	—	—	—	—	—	107 08
Postage, telegrams, express, . . .	—	—	—	2 50	—	—	—	—	—	—	—	—	2 50
Tools, storing and repair of same, ...	—	—	—	5 72	—	—	—	—	—	—	—	—	5 72
Pattern for manholes, tarring tank, etc.	1 65	117 26	—	40 00	—	—	—	—	—	—	—	—	158 91
Expenses of apportionment	595 41	—	27 33	1,874 51	—	—	—	—	50 00	—	—	—	2,497 35
Commission, ...	—	—	—	—	—	—	—	—	—	—	—	—	50 00
Design for regulator, . . .	—	—	—	—	—	—	—	—	—	—	—	—	—
	\$23 18	\$596 96	\$567 19	\$2,292 91	\$486 69	\$447 88	\$521 47	\$374 90	\$389 71	\$399 48	—	\$702 78	\$7,703 15

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COM-
North Metropolitan System. (By Localities.)

		1891.			1892.			
		October.	Novem-ber.	Decem-ber.	January.	Febru-ary.	March.	April.
1	Deer Island, . . .	\$303 67	\$17,516 93	\$8,812 70	\$6,032 81	\$2,002 84	\$33 83	\$27 00
2	Shirley Gut, . . .	-	-	-	-	72 41	27 74	89 43
3	Winthrop, . . .	21,062 12	10,583 05	11,600 03	9,508 55	61 47	5,026 14	4,697 37
4	Belle Isle Inlet, . . .	62 20	206 36	797 65	1,588 83	176 39	284 60	223 97
5	East Boston, . . .	16,812 61	15,171 43	11,489 48	10,902 26	15,493 23	4,609 12	6,573 90
6	Chelsea Creek, . . .	-	-	-	-	-	83 40	69
7	Chelsea, . . .	9,826 36	3,686 22	8,613 13	9,291 49	7,908 07	6,628 16	16,256 53
8	Everett, . . .	14,884 44	14,989 50	17,248 30	20,420 64	21,992 31	12,185 55	10,062 09
9	Malden River, . . .	-	-	-	-	-	-	24 01
10	Medford, . . .	710 45	3,035 84	3,062 61	16,509 56	16,221 23	19,869 74	26,549 86
11	Malden and Melrose Branch, . . .	1,409 09	3,256 62	2,656 42	2,574 44	2,553 72	3,706 31	3,774 41
12	Malden Bridge, . . .	-	-	-	46 85	9 29	132 47	50 00
13	Charlestown, . . .	1 97	8 24	108 74	458 78	435 34	625 33	4,759 18
14	Somerville, . . .	13 09	6 67	39 87	10 27	87 45	1,089 69	1,828 51
15	Cambridge, . . .	6 50	-	28 86	225 46	229 22	169 93	91 25
16	Stoneham and Cum- mingsville Branch, . .	-	-	-	-	-	-	22 48
17	Alewife Brook Branch,	5 29	-	-	-	-	-	-
18	Winchester, . . .	-	-	-	-	-	-	-
19	Woburn, . . .	-	-	-	-	-	-	-
20	Whole system, . . .	267 80	576 24	648 20	790 85	573 46	565 51	774 59
21	Totals, . . .	\$65,365 59	\$69,037 10	\$65,095 99	\$78,360 79	\$67,876 43	\$54,307 52	\$75,810 27

Charles River Valley System. (By Localities.)

22	Whole system, . . .	\$212 32	\$135 75	\$179 52	\$95 68	\$97 71	\$85 58	\$348 66
23	Boston, . . .	11,740 10	7,173 77	1,887 78	5,995 93	3,301 88	1,852 81	23 58
24	Brookline, . . .	90 57	50	-	-	-	-	-
25	Brighton, . . .	19,868 33	13,469 17	15,246 52	10,621 33	2,330 67	6,856 78	2,421 51
26	Newton, . . .	13,474 73	14,432 20	13,047 25	13,801 84	3,253 73	3,493 51	6,850 81
27	Watertown, . . .	9,939 48	5,828 14	1,893 51	3,806 04	813 91	353 59	708 52
28	Waltham, . . .	-	-	-	-	-	-	-
29	Totals, . . .	\$55,325 53	\$41,039 53	\$32,254 58	\$34,320 82	\$9,797 90	\$12,642 27	\$10,353 08

Both Systems.

30	General, . . .	\$923 18	\$596 96	\$567 19	\$2,292 91	\$486 69	\$447 88	\$521 47
31	Grand totals, . . .	\$121,614 30	\$110,673 59	\$97,917 76	\$114,974 52	\$78,161 02	\$67,397 67	\$86,684 82

MISSIONERS FOR THE YEAR ENDING SEPT. 30, 1892.

North Metropolitan System. (By Localities.)

1892.					Total.	Expended to Sept. 30, 1891.	Grand Total.	
May.	June.	July.	August.	September.				
\$34 82	\$341 89	\$3,210 68	\$128 07	\$120 52	\$38,565 26	\$134,844 66	\$173,409 92	1
76	29 56	284 54	13 18	693 03	1,210 65	431 50	1,642 15	2
4,210 11	67 55	583 77	185 10	49 37	67,634 63	406,445 27	474,079 90	3
376 40	776 86	499 12	9,104.66	10,904 31	25,001 35	2,094 32	27,095 67	4
5,149 21	4,500 52	1,532 59	1,007 84	2,971 45	96,218 64	122,568 18	218,786 82	5
33 29	-	1,066 37	30	313 75	1,497 80	544 23	2,042 03	6
20,541 16	15,652 62	56,663 58	32,845 20	42,990 51	230,963 08	9,843 64	240,806 67	7
18,191 86	20,457 21	22,731 95	20,280 97	16,650 33	210,075 15	8,471 46	218,546 61	8
5 70	-	-	-	2 12	31 83	161 97	193 80	9
22,064 30	16,668 57	20,126 41	8,109 58	6,093 45	158,271 60	2,364 88	160,636 48	10
8,391 56	6,266 13	7,639 68	10,484 30	12,311 06	65,023 74	2,398 32	67,422 06	11
6 00	-	-	21 10	371 27	636 98	298 14	935 12	12
371 58	5,762 23	7,454 44	8,595 96	967 96	29,549 75	725 05	30,274 80	13
2,090 40	1,927 30	4,041 43	7,097 67	2,941 30	21,173 65	782 61	21,956 26	14
39 29	825 48	1,888 96	2,069 48	1,403 56	6,977 99	727 74	7,705 73	15
257 98	28 58	379 13	-	868 93	1,557 10	55 56	1,612 66	16
14 82	87 99	277 90	-	540 10	926 10	29 45	955 55	17
7 20	9 33	22 42	12 25	4 11	55 31	-	55 31	18
88	-	-	-	-	88	-	88	19
864 50	342 05	496 15	366 92	1,160 78	7,427 05	6,671 63	14,098 68	20
\$82,641 82	\$73,743 37	\$128,899 12	\$100,302 58	\$101,357 91	\$962,798 49	\$699,458 61	\$1,662,257 10	21

Charles River Valley System. (By Localities.)

\$330 19	\$284 61	\$34 93	\$58 45	\$167 71	\$2,031 11	\$2,909 21	\$4,940 32	22
3,308 37	89 27	11 36	-	59,102 11	94,486 96	101,548 17	196,035 13	23
10	-	-	-	-	91 17	857 49	948 66	24
3,490 32	307 54	1,172 34	12 31	79 75	75,876 57	201,056 28	276,932 85	25
2,207 22	6,891 36	905 98	829 42	1,523 34	80,711 39	58,404 15	139,115 54	26
1,278 46	2,082 38	163 71	151 80	91 55	27,111 09	34,678 34	61,789 43	27
-	-	-	-	-	-	25 10	25 10	28
\$10,614 66	\$9,655 16	\$2,288 32	\$1,051 98	\$60,964 46	\$280,308 29	\$399,478 74	\$679,787 03	29

Both Systems.

\$374 90	\$389 71	\$399 48	-	\$702 78	\$7,703 15	\$8,294 06	\$15,997 21	30
\$93,631 88	\$83,788 24	\$131,586 92	\$101,354 56	\$163,025 15	\$1,250,809 93	\$1,107,231 41	\$2,358,041 34	31

